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## THE HAZARDS OF PARACHUTING

By P ESSEX-LOPRESTI

SURGICAL SPECIALIST, 225 PARACHUTE FIELD AMBULANCE

THE many popular beliefs about the dangers of parachuting are gratifying to the men who parachute, but they are a poor compliment to the devoted band of men who have made it almost foolproof. Parachuting to-day, although one of the greatest thrills in life, is almost as safe as crossing a crowded street, and safer than playing Army football.

It is the purpose of this paper to examine the hazards of parachuting, employing the data provided by 20,000 jumps by men of the Sixth Airborne Division between January and November, 1944. All these descents were made by trained parachutists who had received their "wings" after completing their eight training jumps.

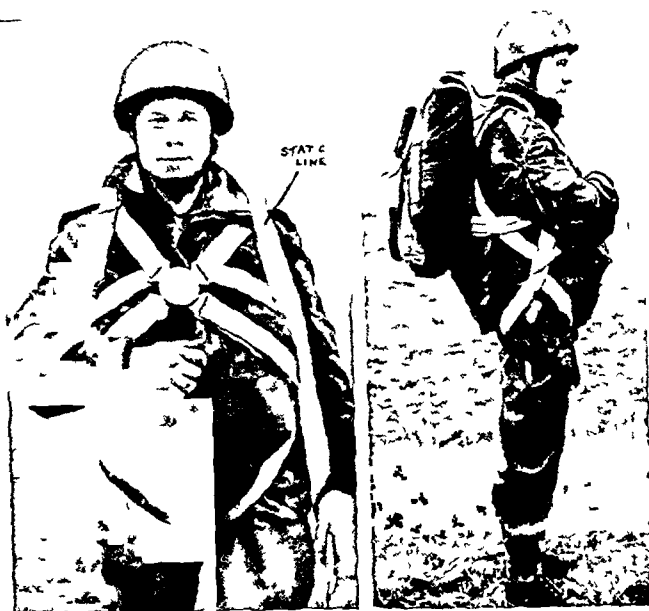
Until now the literature on parachuting injuries is mainly American and covers the training period only. Tobin et al (1941) give the injury rate at the Parachute Training School, Fort Benning, in 1941 as 2.4 per cent, with a hospital admission rate of 0.7 per cent (25 per cent of injuries). The men were trained to land with feet apart, and 19 per cent of injuries were fractures, all but 3 of the 25 being of the lower limb. In June, 1943, the Americans adopted the British "feet and knees together" landing, and their casualty rate from all training causes fell from approximately 9 per cent to 3.5 per cent; the parachuting injury rate is not stated (Lord and Coutts, 1944). These figures include those whose injury caused the man to lose one day or more from duty, and for this reason the figures are not comparable with ours.

During training every man is taught the safety precautions which are taken on his behalf and the rules he must observe to ensure his own safe descent. It is astonishing how careless the parachutist becomes after he leaves the parachute school, perhaps it is due to his confidence in his equipment, but there is no doubt that the majority of injuries are his own fault and could have been prevented.

### THE STATICHUTE

Before the various causes of injury during descent can be appreciated it is necessary to understand the statichute and its mechanism. 86 sq yd of silk or nylon, forming a canopy 28 ft in diameter, and 28 rigging lines attached to the harness are packed in a bag on the man's back (Figs 1, 2). The bag is attached to the plane via a strong webbing belt,

the static line. During the initial free drop following the jump the static line is pulled out to allow the parachutist to get clear of the plane and slipstream. His further fall pulls out first the rigging lines and then the canopy from the bag, which is ultimately



FIGS 1, 2.—The statichute and harness. Note the static line in the parachutist's left hand. (New York Times)

left trailing behind the plane. As the canopy fills with air (i.e., develops) the free fall of the parachutist is slowed and he floats to earth at approximately 14 ft per second. During the descent air has to escape from the canopy, and a vent, 22 in in diameter, is provided at the top, which prevents the air spilling out under the periphery, first one side and then the other, and thereby causing the man to oscillate. Oscillation is dangerous, because the ground may be reached at any stage in the swing, and control of the landing position of the body therefore impossible (Fig 3). The rigging lines are attached at their lower ends to a comfortable webbing harness which is designed to be removed quickly on landing to prevent the parachutist being dragged in a wind and to enable him to be ready at once to deal with any other dangers which may confront him in enemy territory.

### THE DESCENT

Injuries occur during three phases of the descent, and the following description will lay special emphasis on the dangers of each stage. The three phases are (1) The exit from the plane, (2) The development of the parachute, (3) The landing.

**1 The Hazards of the Exit**—There are two routes of exit for the parachutist, depending on the type of plane in use. (a) The door exit from the side of the fuselage, and (b) The hole in the floor, the size of which varies with the particular aircraft.

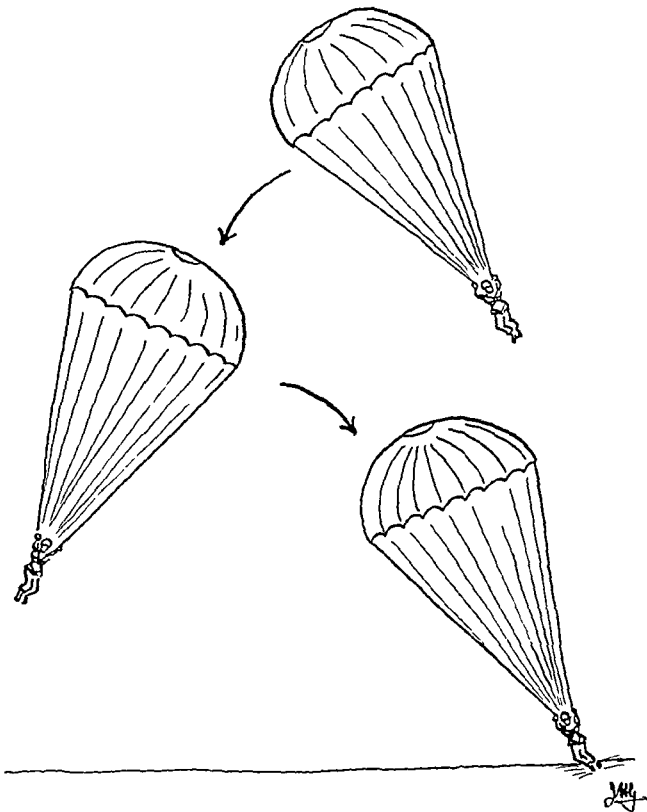


FIG 3—Oscillation. Landing on the swing

*a The Door Exit*—The leading man stands in the door with his static line passing to the runner or 'strong point' on the opposite side of the plane, and the remainder of the 'stick' are lined up behind him (Fig 4). Each man guides the attachment of his static line along the runner as he moves back to the door and then, dropping it behind him, turns and jumps out as close behind his predecessor as he can. If the static line is not held correctly in the left hand it is possible for it to slide up in front of the left arm on its way from the parachute pack to the runner. In this case, as the man jumps, the line flings his arm into extreme abduction and external rotation and usually dislocates the shoulder-joint, or causes a severe sprain with bruising of the upper arm (Fig 5).

It will be obvious that, as the man drops, his static line will whip down the rear lintel of the door to the lower corner, but sometimes as it goes it will



FIG 4—Ready to jump from a Dakota. Note the static line of No 1. (Picture Post)

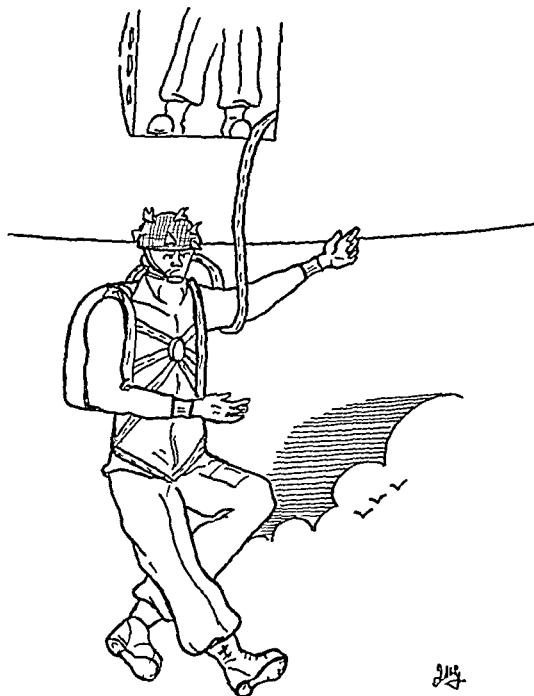


FIG 5—Door-jump with the static line caught in front of the arm

flick like a snake, and the wise parachutist will watch for this out of the corner of his eye as he follows and avoid tripping over it. If he does trip he may somersault.

*b The Floor Exit*—With the small aperture the exit is made seated, the hands being used to push off from the edge while the body is thrown into a position of rigid "attention" with the neck braced back. Successive jumpers swing into the aperture and push off as quickly as possible (*Fig 6*). The main risk is due to failure to hyperextend the neck, so that the body tilts forward and the chin, nose, or forehead strikes the opposite side of the aperture (*Fig 7*). At the training school this mishap is called "ringing the bell" and costs its victim a round of drinks. Once again the weaving static line of one's predecessor must be watched as the swing into the hole is made, especially by men jumping from aft.

The larger apertures enable the men to approach stooping or crouching and to jump out as they reach the edge (*Figs 8-10*).

**2 The Hazards of Parachute Development**—The rigging lines are pulled out in two bands rising from the shoulders of the harness. The steady opening of the canopy is felt by the jumper as a smooth and powerful pull, and all at once he finds himself swinging gently, apparently stationary above the countryside (*Figs 11-14*).

Most of the accidents in this stage are the result of a faulty exit from the plane, which has caused the man to somersault or twist. Somersaulting brings no particular added danger provided a good

with one foot caught in the rigging lines and the countryside apparently above him. There is always time during the descent to disentangle oneself, and it is seldom that a landing is made upside down.

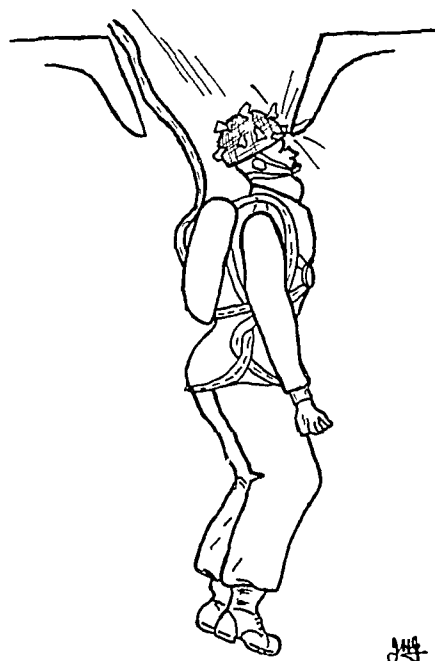


FIG 7—'Ringing the bell'



FIG 6—A good jump position going through the small aperture (*Picture Post*)

jump position is maintained, with legs together and arms well tucked in, for the somersault is then made clear of the rigging lines. But in the slipstream this is easier said than done, for the rush of wind seems determined to force the legs apart, and many a man has found himself swinging gently

Lord and Coutts (1944) report a case of tear of the perineum from a rigging line which passed between the man's legs as he somersaulted. With the American 'chute the canopy opens first and the free fall of the parachutist is arrested with a jerk, and this injury has not been seen from similar accidents over here.

In the course of these aerobatics a sharp flick from the silk rigging lines can produce a burn of the face, arm, or leg.

Twists in the rigging lines are only dangerous in so far as they cause the parachutist to concentrate on kicking himself out of them; he fails to watch the ground and looks like a starfish as he lands.

**3 The Hazards of Landing**—During training a man loses all anxiety in the exhilaration following the opening of his 'chute, and the landing is a minor, inevitable incident after the awe-inspiring leap. But it is on landing that most injuries occur, and the experienced jumper has discovered that his 'chute always opens, and hence the euphoria accompanying the glorious sense of isolation while floating down is tempered by an anticipation of the technical difficulties of meeting the ground. This, during the last 50 ft., rushes up at an ever-increasing speed, and apparently at an angle because of horizontal drift. Quick thinking and determined effort are necessary to make a correct and safe landing. The landing position of the body is relaxed, with

Head well forward, shoulders round,  
Elbows in, and watch the ground (*Fig 15*)

And the English training leitmotiv—"feet and knees together"—is more difficult than it sounds,



FIG 8—Watching for the green light over the large aperture (*Picture Post*)



Fig 10



Fig 9

FIGS 9-11—The bunny hop exit with the medium floor aperture (*Air Ministry photos*)



Fig 11

for the instinctive but dangerous reaction is to spread the legs and throw out an arm to 'save' oneself (*Figs 16, 17*)

The correct landing procedure is to take the initial strain on both legs mutually splinted with the toes pointing across the line of drift, and to allow oneself to roll successively on to the outer side of the leg, thigh, buttocks, and opposite shoulder. It does not matter whether a man is drifting

backwards or sideways, this method can be adapted to give him a safe landing, but he must avoid doing a pitch-forward landing, meeting the ground successively with toes, knees, elbow, and face. Twisting slightly in the harness will prevent this.

Among the other hazards of landing are —  
*a Oscillation*—The importance of preventing this to enable a man to adjust his landing technique to the circumstances will now be appreciated, and

# THE HAZARDS OF PARACHUTING

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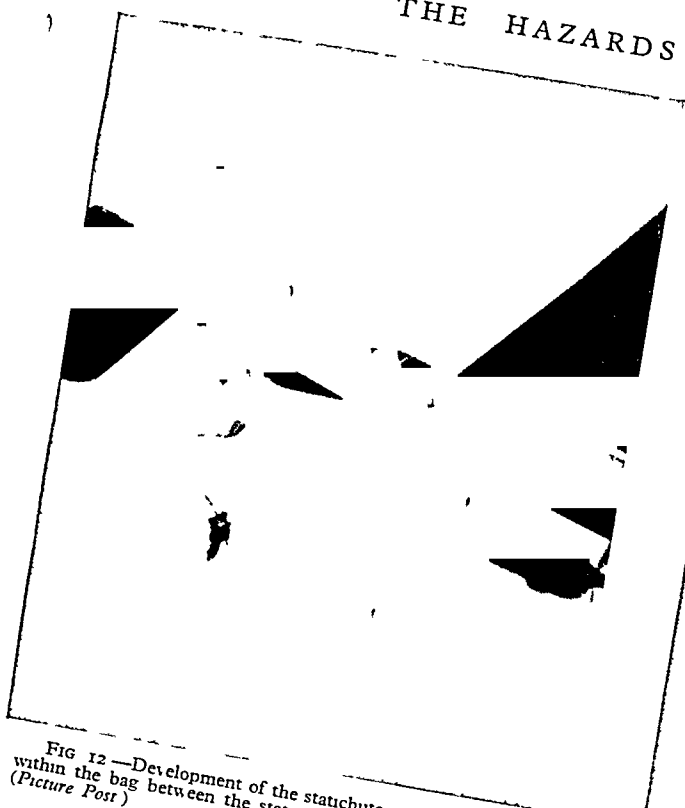


FIG 12—Development of the static chute Canopy is still within the bag between the static line and the rigging lines (Picture Post)

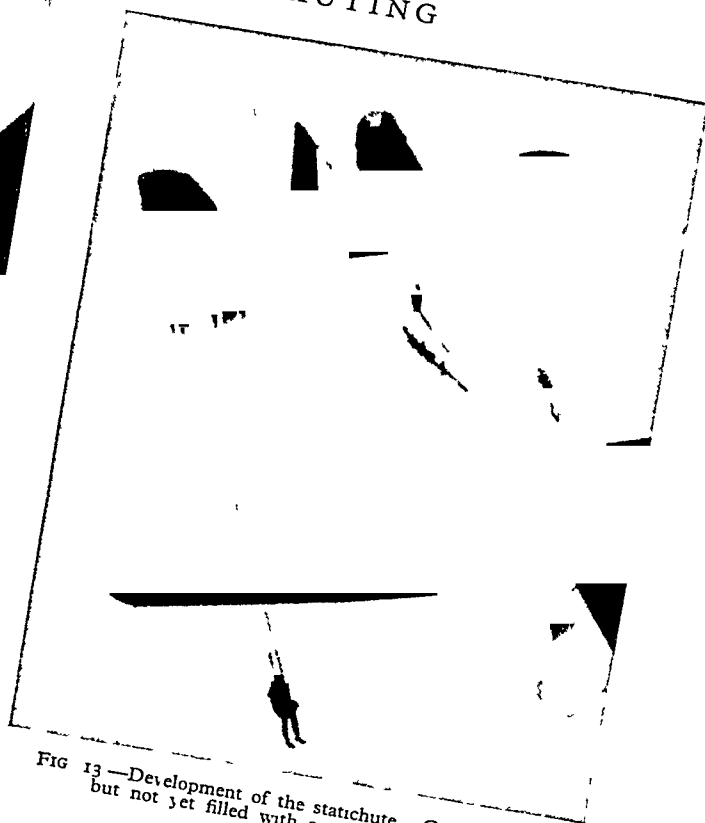


FIG 13—Development of the static chute Canopy clear but not yet filled with air (Picture Post)

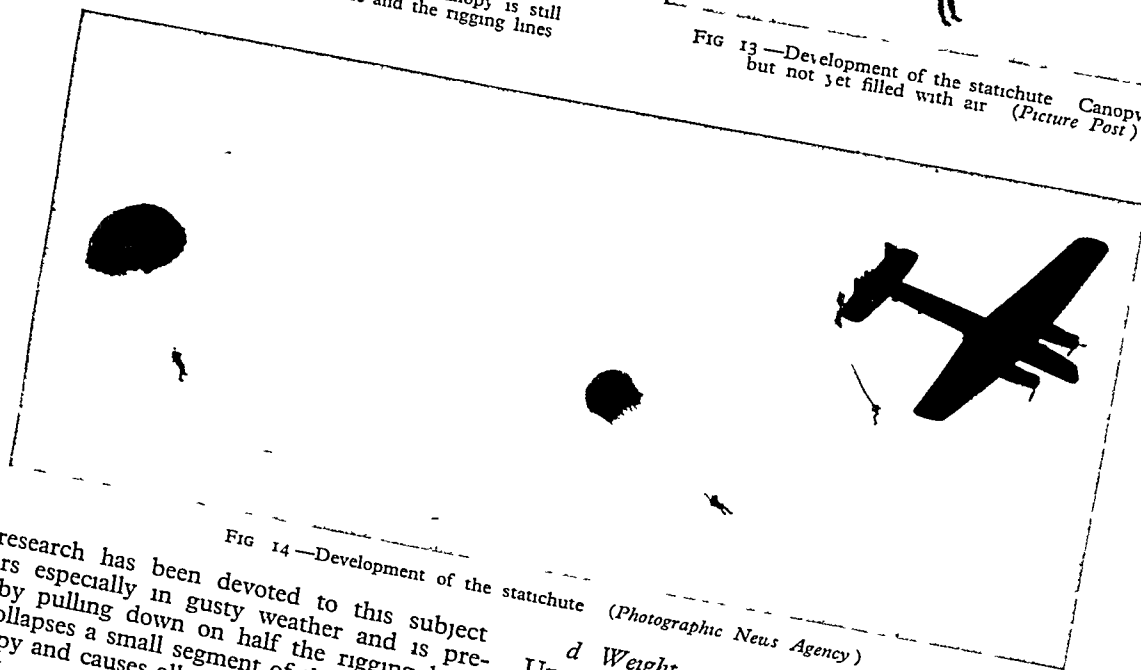


FIG 14—Development of the static chute (Photographic News Agency)

much research has been devoted to this subject. It occurs especially in gusty weather and is prevented by pulling down on half the rigging lines, which collapses a small segment of the periphery of the canopy and causes all the air to spill out on one side only.

*b Nature of the Ground*—This should be firm but not hard grassland or ploughland is suitable. A tree landing is more comfortable than would be supposed (Hygeia, 1942), and the main hazard seems to be falling out of the tree while climbing down, often as a result of misjudging the height.

*c The Wind-speed*—Up to 20 m p h is reasonably safe, though gusting even below that speed may precipitate a near-ground oscillation.

*d Weight and Height of the Individual*—Ungainliness and awkwardness are individual characteristics which may produce accident-prone jumpers. Most of these individuals are weeded out at the training school. The least accident-prone jumpers are the short, stocky types, popularly known as "gnome-oid".

## THE KITBAG

Heavy and bulky equipment is now carried in a bag attached to the leg by a quick-release device. When the parachutist is airborne he releases the bag from his leg and pays it out until it hangs below him by a 20-ft rope. This method of carrying kit has many advantages. Each man on landing has



his own equipment near him at the end of a rope (the advantage of this at night is obvious), the weight of the bag (up to 80-90 lb) steadies him in descent and helps to prevent oscillation. The kitbag reaches the ground about one second ahead of the man, and the sudden reduction of one-third of the

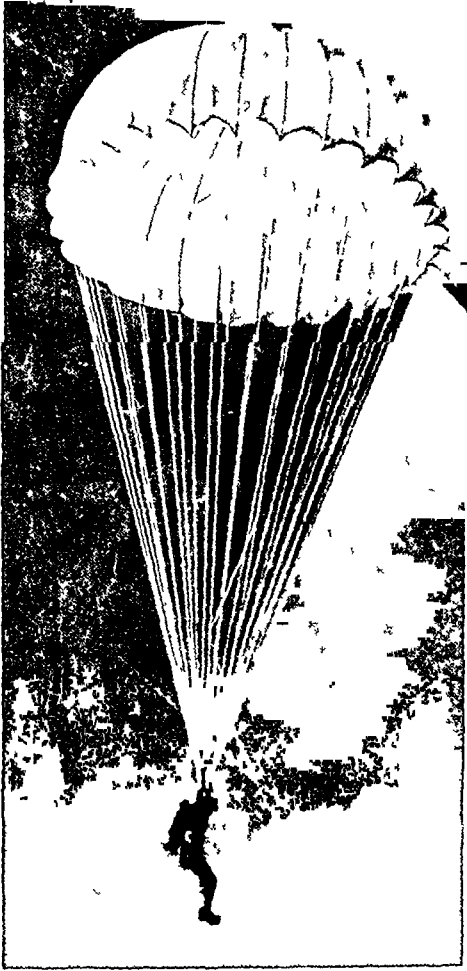


FIG 15—A good parachuting position (New York Times)

parachute's load causes it to "breathe," and most men state that their landings are much less heavy.

The kitbag has, however, its snags. It is clumsy and awkward in the aircraft, and it increases the overall time needed by a stick to leave the plane, which means that they are more spread out on the ground. It is one more gadget for the man to worry about, and released suddenly it may break away from its upper attachment to the harness and hurt somebody below—the shower of 80-lb kitbags during a big exercise is quite terrifying to those already on the ground.

### THE COLLECTION OF CLINICAL AND STATISTICAL DATA

The safety regulations for practice descents demand the presence of a safety officer, with velometer, and a medical officer and ambulance on the



FIG 16—Landing a stage in the roll. The man behind will make a bad 'ballet dance' landing (Keystone)

dropping zone whenever parachutists are dropped. The medical officer is responsible for the treatment of casualties and for recording the following details of the exercise: the wind-speed, visibility, type of aircraft, number of parachutists dropped, and a list of the casualties with their age, weight, diagnosis,



FIG 17—Spreading the legs on landing

and disposal. He is also asked to classify the casualties into those which, in his opinion, would or would not be able to carry on in a fighting capacity.

This method of collecting data allows a certain number of fallacies in interpretation and inaccuracies to appear in the figures, and it will be as well to examine these first—

1 The total number of parachute descents was in fact greater than that recorded because returns of drops with no casualties were not always made. The number is unlikely to exceed 200-300 and would have the effect of reducing the casualty rates.

2 Some minor casualties "slipped the net" and were not recorded on the field. I have traced 61 of these and they are included except in the graphs.

3 The ability to carry on fighting was a personal estimate made immediately after the drop by a number of different doctors. These were all parachutists themselves and knew what degree of fitness was required, and subsequent battle experience has convinced me that their assessment was accurate.

4 Precise diagnosis was not always possible on the field and was usually made later as the acute condition began to settle down. The table of injuries (Table I) tends to be regional, and the details are discussed in the clinical section of the paper.

personal observation I have no doubt that gusting is the dangerous factor, by causing near-ground oscillation.

The fewest casualties occurred with balloon drops (1.1 per cent), probably because these drops

Table II—CASUALTY RATE BY TYPE OF DROP AND WIND-SPEED

TYPE OF DROP	WIND-SPEED IN M P H				TOTAL	PER-CENTAGE CASUALTY RATE
	0-5	6-10	11-15	16-20		
BALLOON No of drops Casualties	298 2	61 3	451 4	— —	810 9	1.1
AIRCRAFT Day { No of drops Casualties	4748 82	8593 152	4087 83	403 20	17,831 337	1.9
Night { No of drops Casualties	2060 23	56 7	20 —	— —	2136 30	1.4
TOTAL No of drops Casualties	7106 107	8710 162	4558 87	403 20	20,777 376	
Add 61 casualties found in Rehabilitation Centre					61	
Total casualties					437	
PERCENTAGE CASUALTY RATE	1.5	1.86	1.9	4.9		2.1

## GENERAL STATISTICS

1 The overall casualty-rate for 20,777 descents was 2.1 per cent (437 casualties), of which only 0.5 per cent were sufficiently seriously incapacitated to prevent them from carrying on fighting (24 per cent of injuries) (Tables II, III).

Table I—CLASSIFICATION OF INJURIES

INJURY	No	PERCENTAGE OF INJURIES	PERCENTAGE OF TOTAL DROPS
CONCUSSION	90	20.6	0.43
STRAINS	181	41.0	0.89
Ankle	71		
Knee	39		
Sup. tibio fibular joint	7		
Shoulder region	28		
Erector spinae	16		
Miscellaneous	20		
DISLOCATIONS	26	5.9	0.12
Shoulder-joint Left	13		
Right	5		
Acromio-clavicular joint	8		
FRACTURES	37	8.5	0.18
Ankle	12		
Tibia and fibular shaft	8		
Metatarsals	3		
Skull/cervical spine	3		
Humerus	3		
Elbow region	2		
Lumbar spine and pelvis	2		
Clavicle	1		
Mandible	1		
Scaphoid	1		
2nd rib	1		
FINGERS (cuts, bruises, rope burns, etc.)	15	3.4	0.07
BRUISES	80	18.7	0.38
MISCELLANEOUS	8	1.8	0.04
TOTAL	437	99.9	2.11

2 Wind speed and type of drop (Table II). These figures had to be calculated on the incomplete total of casualties (376) and are therefore slightly low. It will be seen that wind speed above 15 m.p.h. increases the casualty rate rapidly (Fig. 18). From

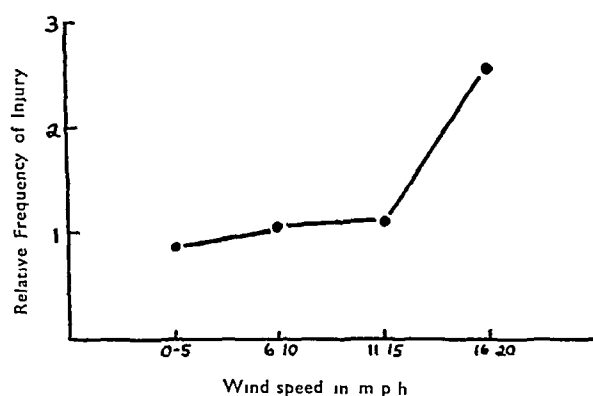


FIG. 18—Effect of wind speed on injury rate

were all made in good weather conditions [the maximum wind-speed was 12 m.p.h. in the series]. Aircraft drops by day caused more casualties (1.9 per cent) than those by night (1.4 per cent). This is the reverse of what was expected, and is explained

Table III—SEVERITY OF INJURY  
(Estimate made on Dropping Zone)

ASSESSMENT OF INJURY*	NO ASSESSED	PROPORTION ADJUSTED TO ACTUAL NO OF CASES	PER-CENTAGE OF INJURIES	PER-CENTAGE OF TOTAL DROPS
A. Man could carry on	320	333	76	99.5
B. Man could not carry on	100	104	24	0.5
Total	420	437	100	100

\* A, Injury not seriously preventing a man from carrying on in a fighting capacity. B, Injury incapacitating a man and preventing him from continuing to fight.

partly by the good weather conditions, and partly by the inability of the parachutist to see the ground his landing position is not spoiled by a last-minute tensing

3 Weight The chart (Fig 19) showing the relative frequency of weight in two battalions and the casualty rate in each weight demonstrates that more casualties occur in the heavier weights

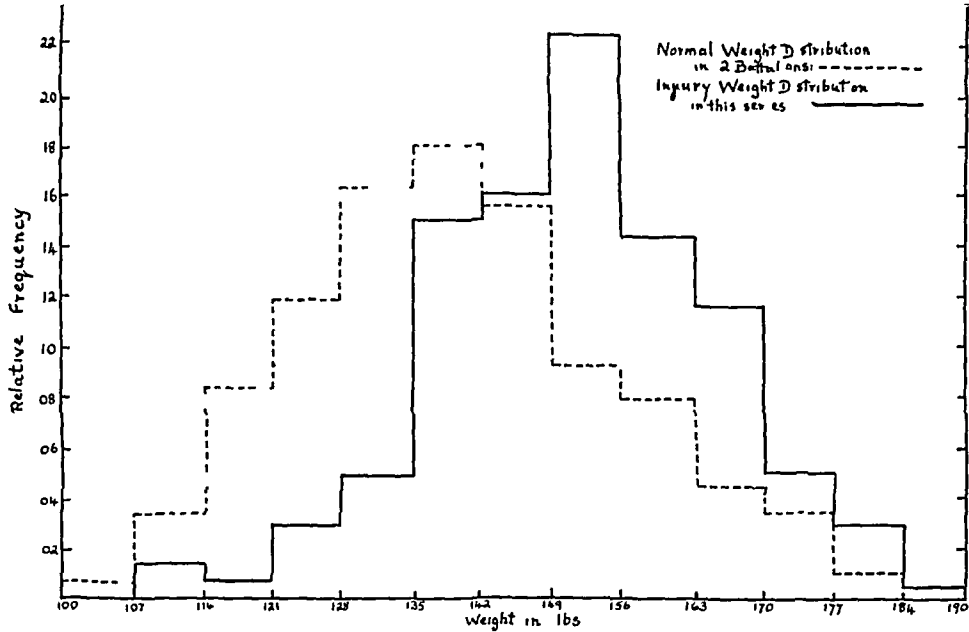


FIG 19—Effect of weight on injury rate

Table IV—CASUALTY RATES ON LARGE EXERCISES (OVER 1000 DESCENTS)

No OF DESCENTS	DAY/NIGHT	WIND-SPEED IN M P H	No OF CASUALTIES	No OF TYPE "B"	PERCENTAGE CASUALTY RATE	PERCENTAGE INCAPACITY RATE
1178	Day	15	20	9	1.7	0.77
1545	Day	0	25	9	1.6	0.58
4500	Day	8-11	42	7	0.93	0.15
1800	Night	0	18	7	1.0	0.38
9023			105	32	1.2	0.35

Table V—INJURIES OCCURRING IN FIRST AIRBORNE DIVISION (APRIL, 1942, TO JANUARY, 1943)

	No OF JUMPS	CONTU-SIONS AND SPRAINS	FRACTURES	CONCUS-SION	FATAL	TOTAL
Aircraft jumps	9203	270 (2.9 per cent)	56 (0.6 per cent)	48 (0.5 per cent)	7 (0.08 per cent)	381 (4.1 per cent)
Balloon jumps	1493	25 (1.7 per cent)	7 (0.5 per cent)	4 (0.3 per cent)	—	36 (2.4 per cent)
Totals	10,696	295 (2.8 per cent)	63 (0.6 per cent)	52 (0.5 per cent)	7 (0.065 per cent)	417 (3.7 per cent)

DISTRIBUTION OF FRACTURES —

Base of skull	1	Spine	7	Femur	1
Nose	6	Cervical	1	Patella	2
Clavicle	6	Dorsal	1	Tibia and fibula	1
Acromion	6	Lumbar	2	Ankle	20
Humerus	6	Coccyx	2	Portals	7
Scaphoid	1	Crush	1	Malleolus	3
Bennett's	1	Ribs	1	Not specified	10
		Pelvis	2		

4 Large exercise casualty rates (*Table IV*) These were all rehearsals for one or other of the Division's operations and the drops were followed by ground manoeuvres. The casualties are fewer than the average, though it is in just these exercises that men tend to rush off without being spotted by the medical officers. The third day drop of 4500 was made as a rehearsal of the Rhine crossing, and the figures are surprisingly low in spite of the fact that on this occasion I was able to follow up and include all those who subsequently reported to the Rehabilitation Centre.

5 Concussion and sprains of all kinds account for 61.6 per cent of the injuries.

6 Fatalities. There were 4 deaths, of which only 1 was the result of the parachute failing to develop fully. The others were unfortunate accidents from unforeseen circumstances.

7 For comparative purposes it is interesting at this point to insert a brief report of injuries occurring in 10,696 drops by trained parachutists between April, 1942, and January, 1943, from a different formation (the First Airborne Division, of Arnhem fame) (*Table V*).

Casualties were not always so light. Rene de Gaulejac (1939) implied heavy casualties in the experiments in the French Army in 1939 and classified the injuries in four groups—

1 Those where the parachutist became entangled with the plane or his chute failed to open and resulted in death.

2 Abdomino-thoracic injuries from the shock of the parachute opening.

3 Diverse organic lesions during the descent.

4 Various severe injuries of the lower extremities on landing.

## CLASSIFICATION OF INJURIES

The following table relates the cause to the injury.

*Table VI*—PARACHUTING INJURIES RELATED TO THEIR CAUSE

<p>I <i>The Injuries of the Exit</i> — Dislocated L. shoulder Strains and Bruises, L. shoulder and arm Cut lip, facial injuries</p>	<p>Static line held wrongly Floor jump 'Ringing the bell'</p>
<p>II <i>The Injuries during Para development</i> Bruises lacerations, and burns from rigging lines</p>	<p>Somersaults and twists</p>

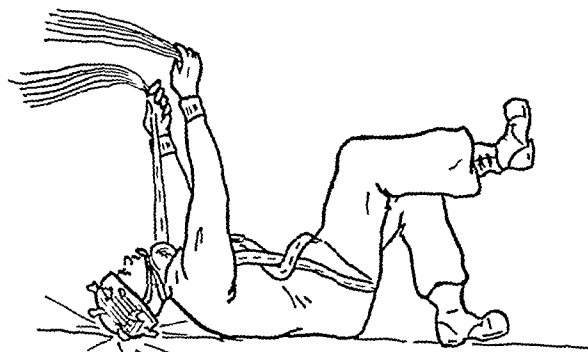


FIG 20—The head whipping back in a backward landing

## III *The Injuries of Landing*

Concussion	Failure to keep head forward
Partial and complete dislocation, acromio-clavicular joint	Shoulders not rounded
Fractured clavicle	Elbows not tucked in
Dislocated shoulder	Separating feet and knees
Strain supraspinatus and deltoid muscle	Badly executed roll
Strain, lateral ligaments of knee and ankle	Feet not parallel to ground
Fracture-dislocation of ankle	
Fracture, tibia and fibula	
Strain, superior tibio-fibular joint	
Strains and bruises of back	
Fractured metatarsals	
Strain of foot	
Traumatic synovitis calcaneo-cuboid or cubo-metatarsal joints	
2nd- and 3rd-degree fracture-dislocations of ankle	

## IV *Kitbag Injuries*

Fracture phalanges of hand	Faulty grip or release of bag
Cuts and bruises of hands	Loss of control in lowering
Rope burns of hands	Landing with bag on leg
Bruises and strains of lower limbs and back	

## SOME CLINICAL ASPECTS OF PARACHUTING INJURIES

**Concussion** (90 Cases)—A common injury, the result of allowing the head to whip back during the roll, especially in a backward landing (*Fig 20*). The period of unconsciousness varied from a few seconds to several days, and about 10 per cent of the cases had evidence of cerebral laceration. Treatment was on routine lines and the results satisfactory, provided the patient's activity was kept below headache threshold and made progressive within this limit. Reassurance and cheerful encouragement were valuable, but recurrent headaches were found to induce depression and a tendency for the man to report sick because he could not keep up with his fellows in the training programmes.

### **Strains** (181 Cases)—

1 **Ankle** (71 Cases)—The vast majority of these were strains of the external collateral ligament. The tenderness was commonest and persisted longest in the anterior talofibular ligament. They varied greatly in severity, and in all cases both ankles were X-rayed with the foot held in strong inversion without anaesthesia. A small proportion of 'tilts' were observed, but none has required operation after rest and physiotherapy. Unfortunately, no follow-up has been done to determine whether healing of the ligament has occurred, but the two or three cases I saw returned to parachuting with no complaint. Most sprains with only a moderate degree of swelling were back to full airborne duties with painless ankles after 10–14 days' treatment. Novocain injection was very unsuccessful in my hands, but it was only used for the chronic cases. Lord and Coutts (1944) state that the length of disability is not shortened by procaine injection in acute cases. There does not seem to be any particular tendency for these cases to recur in subsequent jumps.

2 **Strain of Collateral Ligaments of Knee** (39 Cases)—This, too, was a fairly common injury. Some cases cleared up with treatment in 10–14 days. There was a larger proportion of knee ligament

strains which recurred, and which remained painful for a long time, than was found with the ankle, and traumatic synovitis was, of course, an invariable concomitant. Special attention was directed to the quadriceps muscle from the earliest moment. Recurrent traumatic synovitis with exercise occurred only in those cases where the muscle had been allowed to waste and upset the delicate muscular balance in the joint. In a few of these, stretching of the ligaments developed, and little could be done to restore them to airborne standards. In those cases in which pain persisted novocain injection was tried with little improvement—ionization was more successful, and it did not seem to matter which ion was employed.

There were three examples of torn internal cartilage, confirmed when the acute condition subsided.

One case of rupture of the anterior cruciate ligament was seen in which weakness and letting down were present four months after the injury in spite of two month's immobilization. I lost sight of him after this because he was considered unfit for further parachuting and left the division.

**3 Strain of the Superior Tibio-fibular Joint (7 cases)**—This is an injury peculiar to parachuting, and is rather commoner than the figures suggest, because it is mild, does not always incapacitate the soldier, and is therefore often not reported. Lord and Coutts (1944) report a 'silent' fracture of the upper third of the fibula, and dislocation of the fibular head laterally ascribed to a similar mechanism, and occurring since the American change-over to the legs-together landing. The mechanism is the sideways strain on the leg during the first stage of the roll, or a sideways landing during an oscillation, which 'springs' the fibular head laterally (see Fig 3). Some of my cases have reported that it was the result of a twist of the body after the feet were anchored. Immediately after the injury it is locally painful and tender and is often diagnosed as a minor sprain of the external collateral ligament of the knee. The following day there is usually little or no disability and examination reveals a swelling of the joint with local tenderness. It clears up rapidly and completely without special treatment.

**4 Strains of the Shoulder Region (28 Cases)**—Strain of the deltoid muscle and the supraspinatus tendon form about 50 per cent of this group. I have been expecting to see a complete tear of the supraspinatus tendon, produced by falling sideways on the actively abducting arm. The supraspinatus syndrome has been seen many times, with the characteristic arc of pain on passive movement and the localized tenderness, but all cases have cleared up completely with physiotherapy. It is possible that later some of these men will report with calcification in the tendon. One case of flake fracture of the greater tuberosity of the humerus without dislocation has occurred, and several examples of localized tenderness at or just above the deltoid insertion have been found. The mechanism is presumably similar to that producing supraspinatus strain.

The remainder of the cases in this group are strains of the pectoralis, coracobrachialis, biceps, latissimus dorsi, and teres muscles.

**5 Strain of Erector Spinae (16 Cases)**—Ligamentous and muscular strains of the spine were not very common, but were always something of a problem in treatment. Some recovered quickly and completely with ordinary physiotherapy, but a high proportion complained of recurrent or persistent nagging pain. Ilio-lumbar and ilio-sacral ligament strains were the worst offenders. A few cases were referred to a centre which possessed diathermy and did well, and it is my view that diathermy from the outset would produce a greater proportion of cures. Recurrence was common and it is probable that most of these cases should not be allowed to parachute again.

One interesting case of back injury is worth special mention. A man was sent to the Rehabilitation Centre with acute pain in the lower part of his back following a jump in November, 1944. His history revealed that he had injured his back in a drop two years previously, and this had troubled him on and off ever since, but not sufficiently to prevent him carrying out full airborne training. Clinical examination showed that he had recurrent subluxation of the left sacro-iliac joint, and X-ray examination revealed osteo-arthritis in the joint, which suggested that he had had the condition since the original injury.

A second case of interest is that of an officer who injured his back in a drop in October, 1944, and was diagnosed and treated as a strain of the erector spinae after negative X-ray examination. He was re-X-rayed three weeks later because of absence of improvement, and this showed a compression fracture of the 12th dorsal vertebra. Undoubtedly this would have been seen in the first radiograph if he had been photographed with his spine in flexion.

#### Dislocations (26 Cases)—

**1 Shoulder-joint (18 Cases)**—This occurs in two phases of the descent. (a) With a loop of strop round the arm in a door exit (see Fig 5), and (b) On landing if the elbow is not well tucked in (Fig 21).

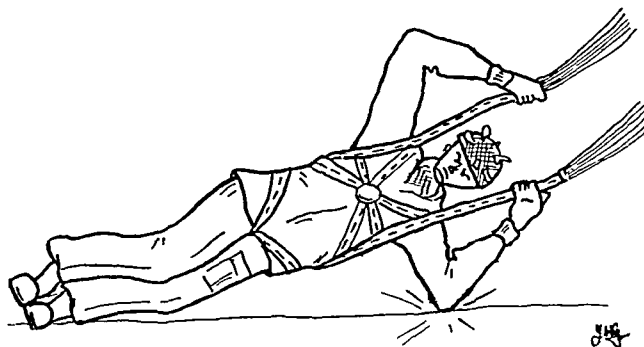


FIG 21—Elbows not tucked in with a sideways landing

With the first mechanism the head of the humerus is driven through the antero-inferior aspect of the capsule, and a subcoracoid dislocation results. One result of dislocation *in extension* has been seen. After reduction and physiotherapy there is no tendency for these cases to recur.

# THE HAZARDS OF PARACHUTING

11

In the second class no case of recurrent dislocation has yet been noted, but as the dislocation can be of any type, with or without coincident fracture of the great tuberosity, and the total number of cases is small, this is probably fortuitous. A factor preventing recurrence is the excellent muscular development and continual training which the men receive. Nerve injuries have been entirely absent from the series.

The best results are obtained if these cases are reduced at once, and the medical organization of parachute exercises makes this possible. The majority were reduced within one hour, and on the following day physiotherapy was started. After an average time of four weeks these cases have full range of movement and can be put on almost full duties.

**2 Partial or Complete Dislocation of the Acromioclavicular Joint (8 Cases)**—This usually resulted from striking the point of the shoulder during an awkward roll, or landing with the elbow or hand flung out. The majority had no residual disability after about five weeks. I have heard the view expressed by orthopaedic surgeons that a permanent subluxation has no disability, and while this is true of some cases there is a small group who do complain of pain with exercise and especially when wearing heavy equipment. It is generally agreed that such cases are unlikely to benefit from operation.

## **Fractures (37 Cases)**

**1 Fracture-dislocation of the Ankle (12 Cases)**—First-, second-, and third-degree external rotation, adduction, and abduction fracture-dislocations of the ankle have been seen. The commonest was a simple transverse fracture of the external malleolus with no displacement, resulting from adduction and inversion of the foot, and Tobin (1941) states that these form 23 per cent of all fractures among jumpers in his series. The third-degree fractures usually resulted from landing on a road, or from 'reaching for the ground' with the toes pointed down (ballet-dancer landing) (Fig 22). Tobin (1943) describes a characteristic fracture caused by reaching for the ground in which the posterior lip of the tibia is sheared off with no other fracture of this type. It is difficult to see how it can occur alone, and Lord and Courts (1944) speak of the typical parachute injury of feet-apart landings, as a fracture of the lower third of the fibula and posterior lip of the tibia. This is really a third-degree external rotation fracture by Ashhurst's classification (1922) and has occurred twice in this small series.

**2 Fracture of Tibia and Fibular Shafts (8 Cases)**—These are nearly always spiral fractures and tend to occur with feet-apart landings, as, for example, when the man is still trying to kick out of twists. It is seldom that these cases parachute again.

**3 Fractures of the Elbow Region (2 Cases)**—Both these cases were caused by landing with the elbow flung out. One was a fracture of the head of the radius with no displacement, which healed up without excision, and the other was a transverse fracture of the olecranon process, also with no displacement.

**Traumatic Synovitis of Calcaneo-cuboid or Cubo-Metatarsal Joint (6 Cases)**—This is

another injury which appears to be peculiar to parachuting and I have not seen it described elsewhere. It usually follows a landing with the feet not quite parallel to the ground. It is painful, especially after rest, and lasts several weeks, with recurrences after marching or P.T. In the acute stage there is swelling over the affected joint line with tenderness, indicative of strain of the capsular ligaments.



FIG 22 — Ballet-dancer' landing

Radiant heat and rest for a week, followed by graded foot exercises, seems to be the best treatment, though I have had two very intractable examples, one of which developed traumatic arthritis in six months (Fig 23). Novocain injection into the capsular ligaments had no effect.

**Bruises of the Coccygeal Region**—Coccydynia is an all too common sequel of a sit-down landing, with considerable pain and disability. Two of these cases were ultimately recommended for excision of the coccyx when all else had failed.

**Effects of Excessive Parachuting**—In this division were a number of enthusiasts who, because they were experimenting with new methods or equipment or because they liked it, performed a very large number of descents. Some had made several hundred. There is no doubt that each of these men have developed marked osteo-arthritis of ankles and knees, and I am certain that the others will show it earlier in life than the average.

**Treatment and Rehabilitation**—It has been found that all sprains, however minor, do better if

actively treated from the earliest possible moment, and the practice of allowing sprains to 'get better by themselves' has been discouraged. These minor sprains do not always become painless, and the time spent later in treatment is out of all proportion to the extent of the injury and the dramatic results of early therapy. In those cases with much



Fig 23—Traumatic arthritis in the cubo-metatarsal joint

swelling, rest in bed until the swelling is beginning to subside, and then and in all other cases radiant heat with graded, active foot and ankle exercises, is the treatment adopted.

Nicoll's (1944) contention that the key to success is restoration of muscle power has been proved true time and time again. The man's natural tendency to drift and wait for recovery must be overcome. Intensive non-weight-bearing exercises can start the day following injury in every case, even if in the earlier stages it is no more than bracing the muscles after radiant heat has eased the pain—the 'facilitation' advocated by Ward (1945).

The complete restoration of the shock-absorbing power of muscles is of paramount importance before parachuting can be resumed and is a severe test of recovery. It has always taken longest with the knee-joint, where the lower fibres of the vastus internus disappear in a few days unless backward bracing is one of the first exercises on the list. But a full range of painless movement is essential too, for any attempt to 'spare' a limb in landing throws

all the strain on to the other, and injury is almost certain to result. Hence the insistence of the divisional surgeons that all cases of sprain must be sent to the Centre, where the necessary exercises can be prescribed and supervised—men told to do 20 minutes thrice daily, don't.

With the shoulder-joint dislocations treatment was started the day following reduction: deltoid bracing first and then active movements in the sling occupy the first week, followed by exercises against gravity and resistance. Throughout treatment great care is taken to ensure that all exercises are, in fact, active and that no arm swinging is done. Arm swinging always has a passive element from momentum, and by further tearing of damaged muscle delays recovery and causes more final fibrosis. In the later stages games to encourage 'impulsive action' (Griffiths, 1943) are employed, for there is little likelihood of a large passive element in medicine ball games.

Faradism has been employed in two classes of case: (i) To assist in the strengthening of weak muscle, where I consider it has very limited value, (ii) to re-educate a muscle to contract when inhibited by injury. Many men are unable, in health, to consciously brace even a group of muscles, and faradism has been found very useful in educating the patient to the 'feel' of his muscle contracting as a facilitation of active movement.

This division has been fortunate in being able to organize and carry out treatment on lines accepted to-day as being ideal in preventing loss of man-hours from incapacity (Nicoll, 1941). Hospital and X-ray facilities were readily available, and a physiotherapy and remedial P.T. gymnasium with a capable and enthusiastic staff under the constant supervision of the divisional surgeons was conveniently situated in the Centre of the area. To this Centre cases were transferred from hospital and referred direct by medical officers for opinion and treatment. The patients lived with their units and attended the Centre daily or thrice weekly, where physiotherapy and remedial P.T. were carried on side by side. A man was never allowed to feel that he had ceased by sickness, whether the result of parachuting, marching, or football, to be an integral part of the division. He was expected to take part in unit P.T. and training programmes as far as he was able, while still attending the centre for specific exercises. His *esprit de corps*, morale, and discipline were kept at a high level by this means, his training did not suffer, and his main concern was to get back into line with his mates, into the full picture of which he was temporarily seeing only a part.

Treatment produced astonishingly quick recovery and consistently good results, but it would be foolish to draw any *hard-and-fast* conclusions from this, or to attempt to compare the results with those of any other centre. The men were constantly in tip-top physical condition; they were a selected group and all volunteers, who despised incapacity and who tended to mask subjective symptoms under the veneer of 'toughness'. They were a group in whom it did more good than harm to assume an incapacity after injury and to oppose their pleas to be back to full duty until it was certain that they

were better, for the demands of their pride were then satisfied without any feeling on their part that their enthusiasm had been exploited. In an environment of this nature the malingerer was rare, and as often as not was 'cured' by the other occupants of his barrack room.

At the same time, because airborne training is hard, it is not surprising to find that a number of cases discharged from treatment asked to be let off certain items of training because of the residual pain it caused, and, for example, because a man had full range of movement following a dislocated shoulder in three weeks it did not follow that he could perform all the rope-climbing tests even after three months.

### SUMMARY

The manner in which the various injuries found after 20,777 jumps by men of the Sixth British Airborne Division were caused is discussed. Most of these were the result of failure to observe the rules of parachuting.

The casualty rate for all injuries was 2.1 per cent, of which 0.5 per cent could not have carried on fighting.

Concussion and sprains constitute 61.6 per cent of all injuries.

Strain of the superior tibio-fibular joint and traumatic synovitis of the calcaneo-cuboid or cubo-metatarsal joints are described as two injuries

peculiar to parachuting. A description of the second has not appeared before.

The Divisional Rehabilitation Centre is described and some comments are made, in the light of experience there, on the treatment of the injuries from parachuting and all other injuries which occur in the training of a division.

I am very grateful to Col MacEwan, D S O, O B E, D F C, T D, A D M S, of the Sixth Airborne Division, for permission to prepare this paper and for the facilities he has placed at my disposal, to the *New York Times*, *Picture Post*, *Photographic News* and *Keystone Agencies*, and the Air Ministry for permission to use photographs, to all the medical officers and surgeons of the Division for their help in the collection of the material and their advice, and to Pte J H Groves, of the Royal Engineers, for the diagrams.

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## INGUINAL HERNIA

### THE UNPREDICTABLE RESULT

By W J M BRANDON, O B E

It is becoming increasingly evident that the inguinal muscular mechanism is now regarded as the key to the problem of oblique inguinal hernia. We must, therefore, obtain an accurate conception of the anatomy and function of this mechanism, together with its capabilities and limitations, before turning to the problem itself.

The credit for this particular approach to the subject in this country must go to Sir Arthur Keith, Sir Heneage Ogilvie, and W J Lytle. Keith (1923) described the shutter action of the conjoint tendon and drew attention to the fact that it is not the presence of a patent process of peritoneum that accounts for the frequency of hernia in man, but a weakness in the groin which has resulted from his upright posture. Ogilvie (1937) must receive credit for being the first to realize that the internal ring must be protected by a mechanism not entirely dependent on the simple shutter action of the conjoint tendon and for pointing out that the most potent factor in the production of an oblique hernia, certainly of the acquired type, is a prolapse of the cord. He has attributed the integrity of the internal ring to its close fit round the cord, to the unusual strength of the transversalis fascia forming its margin, to a well-developed conjoint tendon, and to the recoil action of the cremaster, which draws "the

whole cord up to the internal ring, even invaginating it into the abdomen", against the thrust of intra-abdominal pressure. As a natural corollary to these views he has asserted that it is essential to restore, and not to interfere with, the normal anatomy and function of the inguinal canal except where the mechanism has been damaged beyond repair. Lytle (1945) has shown that the internal ring has mobility and is protected by "an active closure mechanism in which the ring, under stress, moves upwards and outwards under cover of the internal oblique and transversalis muscles". His explanation is particularly valuable, for it alone can account for the internal ring remaining intact in the presence of a direct hernia—where the posterior wall has been stretched, the cremaster thinned out and distorted, and the conjoint tendon rendered incompetent. These authors have, between them, provided the data for the solution of the inguinal mechanism, and all that remains is to correlate their findings. For this purpose it will be necessary to allude briefly to the anatomy of the adult male inguinal canal.

### THE INGUINAL CANAL

The following description has been based on the published work of Ogilvie and Lytle after a careful check both at operation and post mortem.



The inguinal canal lies above the inner half of Poupart's ligament and is covered by the external oblique aponeurosis which splits to form the pillars of the external ring. Medially the external oblique aponeurosis joins the anterior rectus sheath, but it does so a full inch inside the outer border of the rectus muscle, so that for this width the sheath is formed by contributions from the internal oblique and transversalis only. The internal oblique springs from the outer half of Poupart's ligament and the transversalis muscle from its outer third. The

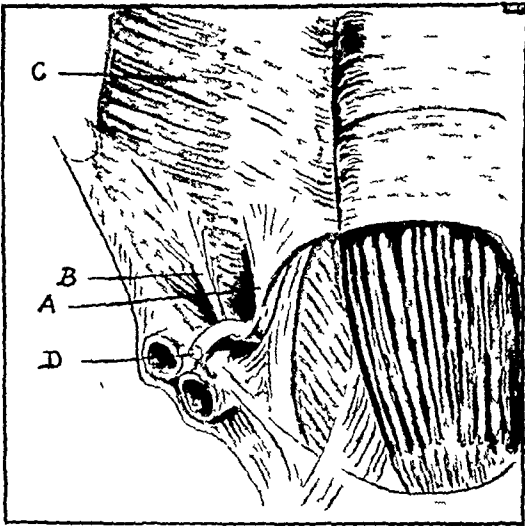


FIG 24—Posterior view of a dissection of the lower part of the anterior abdominal wall. A, Inner pillar, B, Outer pillar of the internal ring, C, Transversalis muscle, D, Vas deferens (After Lytle)

first muscle has the origin of its lowest fibres in front of the internal ring, the second to its outer side. The internal oblique, therefore, covers the ring completely, while the transversalis crosses above it, overlapping it to a varying extent. At this point the muscle layers are distinct, but to the medial side of the ring they blend to form the conjoint tendon, which arches over the cord to be inserted behind it into the pubic crest and the inner inch of the ileo-pectineal line. The conjoint tendon is neither tendinous nor sharply demarcated except at its point of insertion and its lower fibres become thinner and merge with the fibres of the cremaster. The cremaster arises from the middle of Poupart's ligament and the lower border of the internal oblique, and descends over the cord in a series of loops, the longest reaching down as far as the testes. The ascending fibres of these loops pass up along the medial side of the cord and are inserted by a small pointed tendon into the tubercle and crest of the pubis. "In practice these three muscles appear to form one system, through which the descending testis has thrust its way, carrying an abundant covering of muscle fibres with it" (Ogilvie).

The posterior wall of the inguinal canal is formed by the transversalis fascia reinforced at its inner end by the insertion of the conjoint tendon and the reflected inguinal ligament. The transversalis fascia is of considerable strength in this situation and is

firmly attached to Poupart's ligament and the ileo-pectineal line. According to Lytle it consists of two fascial layers—a superficial or "transversalis muscle layer", derived from the fascial covering of the transversalis muscle, and a deeper layer which is the true transversalis fascia. The free edge of the transversalis muscle layer forms what Lytle has described as the "middle ring". At the internal ring the true transversalis fascia is continued over the cord as the infundibuliform fascia.

The internal ring lies to the lateral side of the deep epigastric vessels. "The ring itself is not round, but U-shaped and incomplete above it. It has a thick and strong inner margin or pillar, a thinner outer margin, and an angle below. In the adult the opening measures from 12 to 20 mm in height and from 6 to 10 mm in breadth. It is covered on its anterior surface by the transversalis muscle, the angle of the ring lying just below the edge of this muscle to allow free passage of the cord. The ring is composed of strong U-shaped fibrous strands of varying length, the ends of which are attached firmly as slings to the posterior aspect of the transversalis muscle. On each side of the ring the strands spread out in a fanwise manner, those on the outer side pass up to be attached to the transversalis muscle as far as the anterior superior spine, while those on the inner side gain attachment to the aponeurosis of the transversalis muscle" (Lytle) (Fig 24).

### THE INGUINAL MECHANISM

These anatomical points are all of importance when we come to consider the normal defences of the inguinal canal—a region which must provide unimpeded passage to the spermatic cord and yet withstand considerable variations of intra-abdominal pressure. Nature has provided a defence which varies in strength in direct proportion to the pressure. When the pressure is low or increased gradually, the inguinal canal depends for its security on a simple valvular opening or baffle which acts in much the same way as the oblique insertions of the ureters into the bladder act as baffles, preventing regurgitation of urine when the bladder is distended, but when the pressure is increased suddenly by the contraction of the abdominal muscles an active muscular defence is called into action. The same contraction which increases the pressure guards the canal against its effects.

Whenever the intra-abdominal tension is raised, and therefore whenever there is a *vis a tergo* tending to thrust the abdominal contents through the posterior wall of the inguinal canal or to propel them through the internal ring and along the pathway of the spermatic cord, the external oblique aponeurosis becomes taut, approximating the pillars of the external ring and resisting the tendency of the deeper layers to bulge outwards. At the same time the external oblique aponeurosis pulls on the rectus sheath and steadies it over the rigid pillar of the contracted rectus, so that the deeper muscles are able to exert their maximum contractile effort. The arched fibres of the internal oblique and transversalis muscles straighten, bringing the conjoint tendon down towards Poupart's ligament. The conjoint tendon, however, does not close down

on Poupart's ligament, "like the upper eyelid on the lower," because the tendinous portion, whether it is inserted into the pubic crest and ileo-pectineal line or into the rectus sheath alone, is relatively immobile. So that the straightening of the conjoined tendon which occurs during active contraction is restricted almost entirely to the muscular portion of the tendon (Fig 25). In this way a narrow triangular defect remains, with its apex at the origin of the internal oblique and its base at the point of emergence of the cord. This defect does not constitute a weakness so long as the conjoined muscles retain their tone, for the wider portion of this gap is

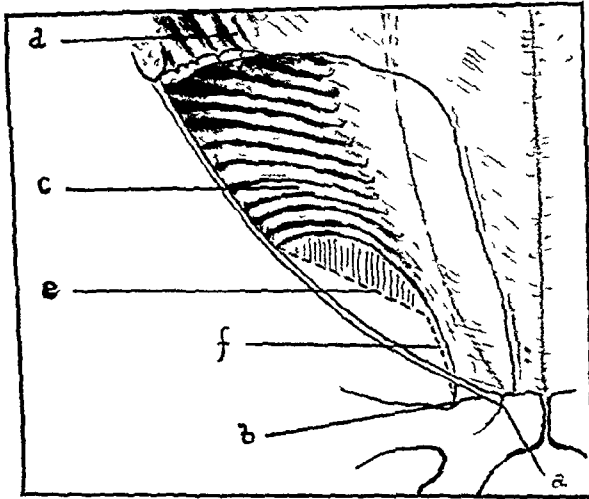


FIG 25—Diagram indicating the extent of closure of the conjoined tendon when contracted. *a*, Pubic spine, *b*, Pubic crest, *c*, Internal oblique, *d*, External oblique muscle (cut away), *e*, Shows the straightening of the muscular portion of the conjoined tendon during contraction, *f*, Shows the semi-rigid portion of the conjoined tendon which is relatively immobile.

strongly protected from behind by the insertion of the conjoined tendon, while the slit-like apical portion is protected by the tautened superficial or "transversalis muscle layer" of the posterior wall, which, owing to its attachment below to Poupart's ligament and above to the free border of the transversalis muscle, is pulled over the cord when the transversalis muscle contracts down in front of the cord like the cover of a roll-top desk. The temporarily imprisoned cord, by virtue of its position and bulk, acts as a support or cushion to the posterior wall of the inguinal canal (Fig 26). This simple shutter action provides complete protection to the posterior wall against the outward thrust of intra-abdominal pressure. When it fails, two types of direct hernia occur—a saucer-shaped bulge due to a stretching of the entire posterior wall, or a funicular sac which appears to the lateral side of the insertion of the conjoined tendon and is associated with a localized congenital weakness or defect in the transversalis fascia.

The same mechanism which defends the posterior wall of the inguinal canal actuates the mechanism that protects the internal ring. The internal ring is overlapped completely by the internal oblique muscle, so that this muscle forms a constant protective barrier to the outward thrust of

intra-abdominal tension at the ring, and it is left to the transversalis muscle to provide the additional protection under stress. When the transversalis muscle contracts as part of the conjoined tendon, the "U-shaped strands", because of their arrangement and particular attachment to the posterior

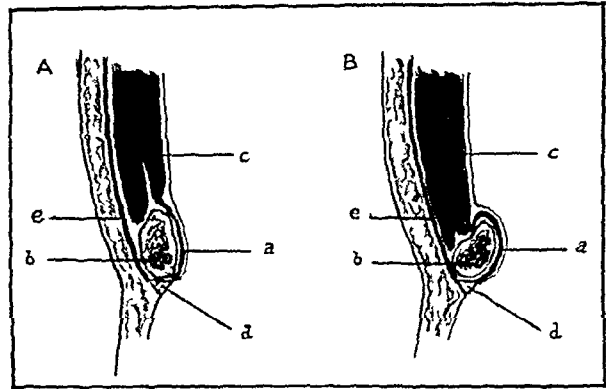


FIG 26—Cross-section of the inguinal canal lateral to the insertion of the conjoined tendon. *a*, Transversalis muscle layer of the posterior wall, *b*, Spermatic cord, *c*, Conjoined tendon, *d*, Inguinal ligament, *e*, External oblique aponeurosis. A, Resting phase, B, During active contraction. The cord is firmly compressed between the external oblique aponeurosis and the transversalis fascia of the posterior wall, and wedged into the gap between the contracted conjoined tendon and the inguinal ligament.

surface of the oblique fibres of the transversalis muscle, grip the emerging cord by approximating the pillars of the ring and pull the whole ring upwards and outwards. At the same time, the free border of the transversalis muscle straightens and moves downwards, thus constituting the "active closure mechanism or sliding valve," described by Lytle (Fig 27, A, B). This upward and outward movement of the ring serves a threefold purpose: it tenses the deep or true transversalis

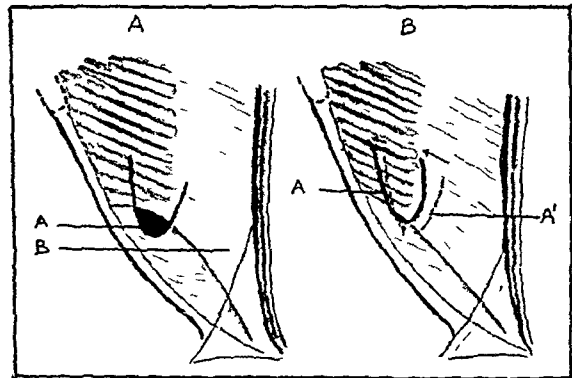


FIG 27—Diagrams showing the outline of the internal ring viewed from within the abdomen with the transversalis muscle relaxed (A), and in contraction (B). *a*, U-shaped strands, *a'*, Shows position at rest as compared with position during active contraction of the transversalis muscle (*b*). Arrows indicate the extent of movement. (After Lytle)

fascial layer of the posterior wall by lengthening the inguinal canal, it imparts an upward pull on the cord by means of the infundibuliform fascia, and it angulates the cord at its point of emergence

through the ring, so that the thrust of intra-abdominal pressure is diverted from the long axis of the cord on to an impregnable muscle barrier composed of the internal oblique and transversalis muscles, supported by the tautened external oblique aponeurosis (Fig 28, A, B). It is for this reason that the cord does not prolapse under normal conditions and even presents the appearance of being invaginated

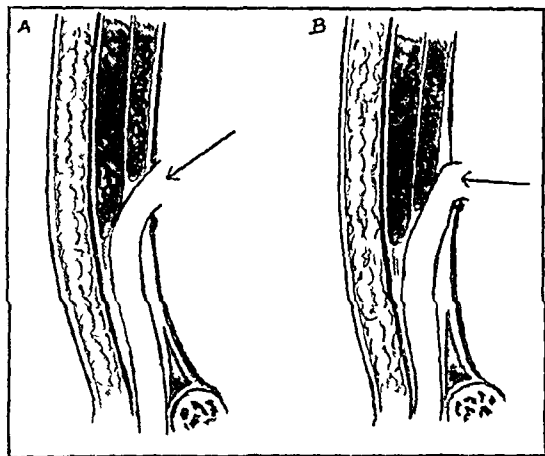


FIG 28—Diagrams to illustrate the angle of emergence of the cord at rest (A) and during active contraction (B). Arrows indicate the line of thrust in the long axis of the cord.

into the abdomen against the full force of intra-abdominal pressure. The appearance is in fact due to a puckering of the peritoneum at the site of the internal ring produced by the upward and outward movement of the ring. If this sliding valve mechanism fails to close completely either as a result of stretching of the U-shaped strands due to an inherent weakness in these ligaments or from a loss of mobility of the ring due to muscle weakness, including nerve damage, the outward thrust of intra-abdominal pressure will act in the long axis of the cord and prolapse it. The same thing will happen if the mechanism is caught off its guard.

The cremaster forms an essential part of the protective mechanism. During the resting phase it counteracts a constant pull on the cord due to the weight of the testicle, but during the active phase it contracts and draws the cord upwards so as to provide enough slack in its upper segment, that is the segment of the cord which lies under cover of the internal oblique, to allow the internal ring to ride upwards and outwards without impediment. Thus it prevents a drag on the ring which would tend to stretch the U-shaped strands and therefore immobilize the ring, and it prevents a drag on the cord which would tend to prolapse it. We find, therefore, that, as Ogilvie originally suggested, the most potent factor in the production of an oblique hernia is a prolapse of the cord, and that this prolapse may be due to a defect primarily affecting the valvular mechanism or secondary to an ineffective cremasteric recoil.

The advantage of such an exposition is that it ascribes to each component of the inguinal mechanism a role well within its capacity, and it helps to

explain why oblique and direct herniæ can, and usually do, occur independently of each other and even at different periods of life. Furthermore, it indicates that a prolapse of the cord is the basic factor in the actual production of an oblique hernia, thereby providing a working hypothesis from which we can determine the mode of production of a congenital and an acquired hernia. But when we come to consider the principles of repair we find that a knowledge of the function of the inguinal mechanism is insufficient, it leaves us free to accept the current opinion that preservation of the inguinal mechanism is the surest safeguard against a recurrence, or to take the opposite view, that the removal of the sac, even when combined with a repair of the internal ring and a careful preservation of the inguinal mechanism, is no guarantee that the factor or factors which were responsible for the breakdown of what was once a well-functioning protective mechanism will not lead to the breakdown of a repaired one. Our immediate problem, therefore, is whether to bear right or to fork left.

### FORK LEFT

As so often happens when we step back from the canvas, not only do we see more of the picture, but we are more able to appreciate its salient features. Let us, therefore, step back from the problem and view the known peculiarities of inguinal hernia in relation to the growing subject and its response to treatment at the various stages in life.

In the newly-born infant the inguinal canal is almost a direct opening through the abdominal parietes, but as the child grows the canal lengthens, till in the adult the internal and external rings are about 5 cm apart. Normally the processus vaginalis is closed at birth, but should it fail to close a potential hernia is present, and many of these potential herniæ become herniæ in infancy and early childhood. Then follows a latent period during later childhood and adolescence when hernia is comparatively rare, and finally, in adult life the incidence rises once more and many herniæ, obviously congenital in origin, make their appearance for the first time. This periodicity of recurrence must have some significance, for if we accept the presence of a patent process of peritoneum as a constant, it means that a contributory factor must be present before the canal begins to develop and again after the development has been completed, or, conversely, that some factor is present during the development of the canal which controls the internal ring so effectively that the presence of a sac is of little or no consequence.

The presence of a sac in infancy must be regarded as a potential source of hernia, for if there is no sac there is no hernia, but the inchoate state of the inguinal canal must be taken into account, for so long as the canal remains a direct, or almost direct, opening the frequency of hernia is high. The subsequent development of the inguinal canal suggests that Nature, at all events, is aware of this second factor and, after extruding the testis by the most direct route possible, staggers the two rings in order to remove this obvious source of weakness. Some tractive agency must be responsible for the progressive migration of the internal ring in a

lateral direction, and the most feasible one is the U-shaped strand formation described by Lytle. So long as these strands are undergoing progressive shortening, and are therefore maintaining a good tension, the internal ring is fully protected. But once the development of the canal is completed, the incidence of hernia rises again, and the only way we can account for it is that the strands tend to slacken

through the incompetent valve mechanism against the anatomical neck, which sooner or later dilates and results in a *congenital* hernia. In view of the presence of a ready-made hernial sac this type of hernia makes its appearance quite rapidly.

In the case of an *acquired* hernia the sac has to start from scratch. It can be shown when the normal inguinal canal is laid open, that traction on

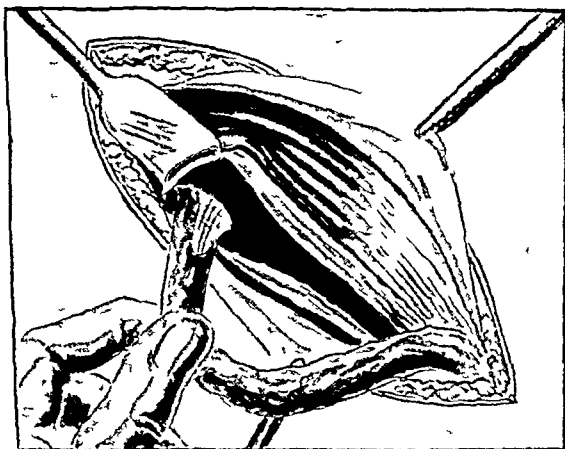


FIG 29—Pull on the cord showing a peritoneal pouch lying within the infundibuliform fascia

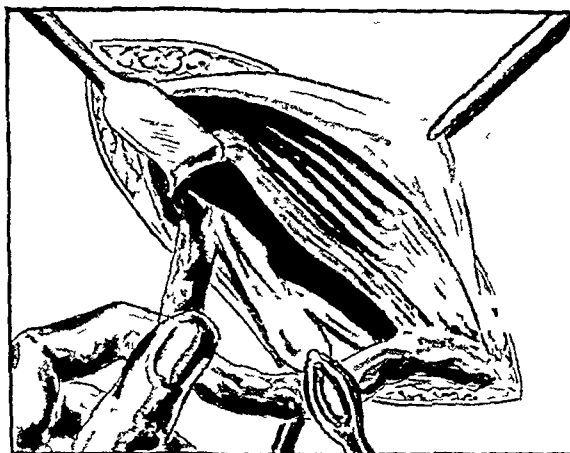


FIG 30—Showing an acquired oblique hernial sac which accompanies the cord but has come to lie outside the infundibuliform fascia

and the internal ring to stretch—a fact which is supported, and more adequately explained, from our study of the adult inguinal mechanism. The question that now arises is whether the presence of a patent process of peritoneum does or does not account for the frequency of hernia in adult man. We find that not only do congenital oblique herniae make their appearance at this time, but that acquired oblique herniae also appear at precisely the same period, and it is interesting to note that they both occur at a time when the muscular structures are in their prime, or at worst, just getting past it. We have acquired the habit of dividing oblique herniae into congenital and acquired types purely on the characteristics of the hernial sac as seen at operation, but is it not possible that the same factor is responsible for both? In other words, is it not possible that the factor which is responsible for the formation of an acquired hernia produces a congenital hernia merely because there is a ready-made sac present to facilitate the process? If this is so, we must prove it, and for this purpose we must envisage the manner in which congenital and acquired herniae develop.

#### Congenital and Acquired Oblique Hernia —

We know, or at any rate we can surmise with reasonable accuracy, that any breakdown or malfunction of the inguinal mechanism leads ultimately to a prolapse of the cord. If there is a preformed sac present it is bound to prolapse with the cord, so that its well-defined anatomical neck comes to lie distal to the internal ring—a fact which is frequently noted at operation. Thus the new neck of the sac is formed from the peritoneum of the abdominal wall and must be funnel-shaped. This funnel guides the full force of the intra-abdominal pressure

the cord will pull down a rounded process of parietal peritoneum through the opening of the internal ring, so a prolapse of the cord must do precisely the same thing. At first, the fundus of the acquired sac lies within the infundibuliform fascia, but since this investing sheath, together with the intimately blended structures of the cord, offers a fair degree of resistance to the fundus of the sac, a greater proportion of the expansile pressure will fall on the neck and lumen of the sac. The sac, however, has no true neck and therefore the pressure acts directly on the margin of the internal ring. This stretches the ring still further, and eventually tears the posterior wall of the canal in much the same way as a playing card can be torn across with comparative ease when a distracting force is applied to its edge, though it will offer the stoutest resistance to an attempt to thrust one's finger through it. Once the posterior wall has been torn the fundus of the sac comes to lie outside the infundibuliform fascia and, no longer meeting with any resistance, is able to accompany the cord as an oblique sac with all the known characteristics of an acquired hernia (*vide* Ogilvie) (Figs 29, 30). It cannot, however, be denied that frequently the sac fails to disrupt the infundibuliform fascia and, therefore, lies within it, but in all other respects it remains characteristic of the type.

It will be readily seen that a repetition of this sequence of events can explain how a *recurrent* oblique hernia is formed though the alteration in the terrain will alter the characteristics of the sac.

**Principles of Repair**—The main point at issue when we come to consider the repair of an oblique hernia is how much reliance can be placed on a repaired inguinal mechanism. We have noted that in childhood the presence of a sac is essential

to the formation of a hernia, but in adult life its presence is no longer a *sine qua non*. Secondly, we know that simple removal of the sac in childhood gives an almost certain cure, but in the adult simple herniotomy, or any other type of repair, is by no means so reliable.

When we analyse these facts, we find that, though the presence of a sac is an essential component of hernia in childhood, a second factor is present—the undeveloped state of the inguinal canal. If the surgeon attends to the first, Nature looks after the second, and success is assured. In fact, at this period of life Nature is so much on the side of the patient that if the hernia is merely treated by a truss, or even neglected altogether, she does her utmost to produce a spontaneous cure. But once the development of the canal has been completed this strong partisanship on the part of Nature ceases, and if the defence mechanism now fails, it has no natural powers of recuperation. The position, with certain limitations, becomes analogous to that of a mechanic faced with the repair of a broken big-end in a motor car. No mechanic worthy of the name would content himself with a mere replacement of the big-end and then state categorically that it would never give way again. He would true the bearing, make sure that there is no whip in the crankshaft, and test the efficiency of the lubrication system as well as replacing the big-end. Figuratively speaking, the surgeon is in a position to true the bearing and replace the big-end—that is, he can remove the sac and repair the inguinal mechanism—but he has no control over the amount of stretching which may take place in fibrous tissue and he cannot restore a defective muscle action. Therefore, he is in no position to give an assurance that the hernia will not recur.

*The Solution*—Here, I must repeat myself, but I do so in the knowledge that it is only a constant

drip that will wear away the stone. When we consider the multiplicity of repairs, including simple herniotomy, we are struck by the fact that the only repair which provides a certain cure in adult life is complete closure of the inguinal canal after removal of the cord and testis. It was on this fact that I based my solution, for every repair, with the exception of Schmieden's operation and my own modification of Ogilvie's method of mobilizing the cord in a lateral direction to allow complete closure of the inguinal canal, preserves the inguinal mechanism in some degree, and it is the preservation of this mechanism either wholly or in part that has made the repair of any given oblique inguinal hernia an unpredictable result.

### CONCLUSION

If we take one last backward glance at the picture as we depart we see that our first visual impression must have been correct, for there is no other way of explaining why that cunning with the scalpel, which seems so universal when dealing with children, should forsake all but the elect when we turn to the adult.

I wish to express once again my gratitude to Sir Heneage Ogilvie, who, in keeping with the greatest exponents and the best teachers in another sphere, has allowed me to retain my swing yet has enabled me to keep the ball on the fairway.

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## THE SURGICAL TREATMENT OF CARCINOMA OF THE ŒSOPHAGUS\*

### WITH SPECIAL REFERENCE TO A NEW OPERATION FOR GROWTHS OF THE MIDDLE THIRD

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THE Œsophagus is a difficult surgical field for three reasons: its inaccessibility, its lack of a serous coat, and its enclosure in structures where infection is especially dangerous and rapid. In the case of carcinoma of this viscus surgery is still more difficult, for several reasons. It involves an extensive resection in a part of the alimentary canal which not only has no serous covering but also no slack. This in itself renders the ordinary procedures of abdominal surgery well-nigh impossible to apply. Moreover, regarded as a thoracic operation its resection is a formidable undertaking in a usually

old and starved patient, and more than any other thoracic operation it threatens the surgeon with having both pleuræ opened during its course. The arteries of the gullet are largely longitudinal and in its upper thoracic course anastomose precariously with branches of the inferior thyroid. It is the direction of blood flow rather than its longitudinal course which besets the surgeon—mainly in the upper third. The contents are commonly septic in these cases. Because of the loosely-knit muscle, anastomosis of its walls has with some reason been described as "suturing the unsuturable." The pioneers realized early that, except for a few growths of the cardia, resection with anastomosis seemed out of the question. Attempts at suture of the

\* Being the substance of a Hunterian Lecture at the Royal College of Surgeons, London, Jan. 10, 1946.

thoracic œsophagus after resection for cancer all failed, and exteriorization seemed the only solution. The new problem created by this would, it was hoped, be solved by œsophagoplasty—a hope which has not been fulfilled.

### HISTORICAL

There are few things in surgery to match the courage and enterprise with which the great surgeons of the last century attacked this problem. First of all the cervical œsophagus, then the cardia by the abdominal route, and finally the thoracic œsophagus was successfully attacked. Much of the work was experimental surgery on animals—usually dogs. As long ago as 1871 Billroth did experimental resections of the cervical œsophagus in animals, and in 1877 Czerny—then Billroth's assistant in Vienna—carried out the first successful resection of the (cervical) œsophagus in man. Seven years later that other famous pupil of Billroth's, von Mikulicz, actually reported a successful plastic reconstruction of the cervical œsophagus after resection for cancer. During the next 20 years (1885–1905) a small number of surgeons, von Mikulicz, von Hacker, Rehn, Sauerbruch, in Germany, Nassilov in St Petersburg, Biondi in Italy, and Gosset and Faure in France, attempted varied methods. Some of these were experiments on animals and some were “*recherches cadaveriques*,” as Gosset quaintly described them. Indeed, an article by Gosset in 1903 shows such a grasp of the essential principles of œsophagostomy that it well repays reading to-day. But none of these surgeons secured an operative recovery in man. In 1908 Voelcker successfully resected the cardia by an abdominal approach, completing the operation by pulling down the œsophagus and joining it to the stomach. A few more successes by this method followed. Kummel (1910), Bircher (1918), Gohrbandt (1927), Ingebrigtsen (1933). The essentials of the Torek operation had been carried out 10 years before Torek's case both by von Mikulicz and Faure, but their patients died. Faure's thoracic approach, however, was very like that of a modern upper thoracoplasty, combined with a cervical dissection. The year 1913 was the date of the first successful transthoracic œsophagectomy by Franz Torek. His patient died a natural death 13 years later at the age of 80. A small number of other successes followed, both abdominal and thoracic. In 1933 Grey Turner reported his successful resection of the œsophagus by the cervico-abdominal or ‘pull-through’ method with construction of an ante-thoracic gullet. The year 1938 is notable for two reports—Garlock's three consecutive successes by the Torek method, and Adams and Phemister's first successful transpleural, transphrenic resection of the cardia with œsophagostomy. It seems likely that that year will come to be looked upon as the turning point in the surgery of the œsophagus—a year which marked the end of 40 years' wandering after elaborate and ingenious devices and a return to simple, straightforward, and meticulous surgery. Exteriorization, invagination, cutaneous flaps, phrenic flaps, pull-throughs, strippers, mediastinal approaches, Murphy buttons, even endoscopic resections (Seiffert, Moersch), all

these must be recognized as methods which, while trying to avoid the acknowledged dangers of œsophageal resection, created new dangers and difficulties of their own. Only with the great advances of the nineteen-thirties in chest surgery and anæsthetics, had the thorax at last been made a place fit for the abdominal surgeon to work in. The rapid increase in the number of resections since 1938 is matched by a steady fall in the mortality. Garlock showed that case after case could be successfully operated on, Churchill and Sweet have shown how low the mortality of these big undertakings can be when carried out with scrupulous care on selected cases.

Outside America, the Japanese surgeon, Ohsawa, must be specially mentioned, because in 1933 he published a series of 20 resections of the lower end of the œsophagus with 8 survivals. The report of this striking achievement was received by Western surgeons almost with incredulity until 10 years later the still larger series and even higher recovery rates of Garlock, and of Churchill and Sweet, confirmed that such results could be achieved and consistently achieved.

**Great Britain**—Whilst in America the number of successful œsophagectomies is now considerable, British surgeons have contributed a good deal to ideas on the subject. Wilfred Trotter, by his thoughtful and deliberate craftsmanship, brought the surgery of the pharynx and cervical œsophagus to a point it had never reached before. Grey Turner has insisted for many years that cancer of the thoracic œsophagus must not be crossed off the surgeon's agenda. He has been rewarded not only by his own success by the abdomino-cervical pull-through method, but by the revived interest in the whole subject. W. H. Ogilvie's article in 1938, based on a case done three years before, was a clear exposition of the difficulties and a source of great encouragement. A short but masterly essay on the surgical anatomy of the œsophagus by O'Shaughnessy and Raven in 1934 remains the best thing written on the operative approach. Successful operations of the Torek type have been reported by Tudor Edwards (1935), Allison (1942), Franklin (1942), Muir (1936)—the last-named employed a dorsal stoma. H. A. Kidd (1943) has had two recoveries by the Grey Turner pull-through method. Successful resection for carcinoma of the lower end with immediate œsophagostomy was done for the first time in this country by Vernon Thompson in 1941. G. H. Steele, of Guildford, reported his case in 1943, and Tubbs in the same year. Dickson Wright published another in 1945. Hermon Taylor (1945) has described an interesting modification whereby both stomach and œsophageal stump are transposed to the front of the sternum and anastomosed there.

It will be agreed that this work demands careful record and discussion, as the field is constantly changing and our views are still in some respects tentative. Those desiring comprehensive recent reviews of the whole subject will consult the painstaking symposia of Clarence Bird (1939) and Ochsner and De Bakey (1941). The following notes are more a record of personal experience and impressions than a composite of other surgeons' views.

## CASE REPORTS

*Case 1*—A J L, a nightwatchman of 73

Admitted Sept 19, 1940, with difficulty of swallowing and food coming back after sticking at suprasternal notch for one month. Loss of weight but fair appetite. A wasted and melancholy old man. No physical signs.

*X-ray Examination* Intrinsic obstruction mid-oesophagus.

*FIRST OPERATION* (Sept 20)—*Gastrostomy* under local procaine. No secondaries apparent.

*SECOND OPERATION* (Sept 29)—*Cervical dissection*, and a loop of silver wire left around upper thoracic oesophagus.

*THIRD OPERATION* (Nov 4)—*Oesophagectomy*. Anaesthetic: right paravertebral block plus nitrous oxide and oxygen (Dr Nagle). Patient in left lateral position. The whole right 5th rib was resected and the 4th and 6th divided at their necks. The growth was at the level of the left bronchus. The azygos vein was divided and the mediastinal pleura incised. Tapes were passed around the oesophagus above and below and then the growth itself freed. There were considerable adhesions to the left bronchus. Only about three oesophageal vessels had to be tied. The oesophagus was divided with cautery 2 in above the diaphragm, distal stump ligated and inverted by a silk suture. The pleura was then drawn over the stump by a third suture. The upper third of the oesophagus was rapidly freed and the growth and proximal end encased in a glove finger. An intercostal catheter was fixed in 9th space. The chest was then closed with fine silk—continuous for the costal bed and interrupted for the muscles. He was laid on his back, the cervical wound reopened and the oesophagus hooked up by the silver loop with no trouble. The gullet was now cut off 2 in above the growth and the remaining stump placed in a subcutaneous tunnel in front of the manubrium sterni, and stitched after a disc of skin had been removed. The cervical wound was closed.

Operation time 2½ hours. 1000 c.c. of blood transfused during operation. Pulse at end 96.

*PROGRESS*—His condition caused no concern except for some oedema at the end of the first week. This was apparently due to hypoproteinaemia. His lung expanded well and the wounds healed without incident. A small purulent discharge followed removal of the pleural tube on the tenth day—drying within a week. He refused to co-operate in using a rubber tube for an oesophagus and was generally in a miserable state. He was discharged in January, 1941. He died six months after the resection, probably from secondaries.

*Comment*—This appears to be one of the oldest patients to survive oesophagectomy. It is remarkable how little he was upset by it. The growth was rather advanced and I was not surprised at his early death.

*Case 2*—V G, age 64, a chef.

Admitted Oct 3, 1941, with dysphagia for seven months. Lost weight—3 st in six months. Had already had a gastrostomy, but could still swallow fluids. Food sticks at manubrium, he says. No physical signs.

*X-ray Examination* Organic obstruction from 9 cm to 5 cm above diaphragm.

*Oesophagoscopy* (Oct 11). Papilliferous new growth at 35 cm. Still some lumen. Biopsy: squamous carcinoma—especially basal cells—no cell nests.

*FIRST OPERATION* (Oct 17)—*Dissection of cervical oesophagus*. Local infiltration. Stripped down towards arch of aorta. Silver wire looped around oesophagus. Wound closed.

*SECOND OPERATION* (Oct 20)—*Torek oesophagectomy*. Paravertebral block, gas and oxygen, then cyclopropane (Dr Quayle).

The whole of the left 5th rib was removed and the 4th and 6th ribs divided. The growth was mobilized

and the oesophagus divided below it. The right pleura was slightly torn during this—plugged with damp swab. Oesophagus was brought out through neck and wrapped in a rubber glove finger. The chest wall was closed in layers, water-seal drainage. Growth resected, oesophageal stump brought through tunnel in front of manubrium. In spite of an interruption of three-quarters of an hour during the operation due to respiratory difficulties, the patient's condition at the end was very fair. Two pints of blood was given.

*PROGRESS*—The next day his condition was fair, the small right pneumothorax was aspirated. His extremities were warm, pulse rapid (120), but of very fair volume. On the third day arrhythmia of the heart was present—the pulse being in threes and fours. The radiograph showed full expansion of lungs. In the next two days his respirations increased, moist sounds developed at the bases, and he died six days after the operation.

Post-mortem examination showed much purulent bronchitis, but no consolidation. There was no pleural infection.

*Comment*—I now think this case might have been saved by timely and repeated bronchoscopic suction. The cardiac arrhythmia, noted by various surgeons in some cases of oesophagectomy, probably had little to do with his death.

*Case 3*—F B, age 43, electrician.

First attended out-patients' Aug 29, 1942, complaining of slight discomfort in swallowing, particularly a raw feeling in the back, between the left scapula and the spine.

*X-ray Examination* "No delay in the passage of a barium bolus with the first swallow" (screening only).

*Oesophagoscopy* (Sept 18). An ulcer  $\frac{3}{4} \times \frac{1}{2}$  in at 28 cm, two-thirds of lumen still open. Biopsy showed squamous- and polygonal-celled carcinoma of the oesophagus with no horn formation.

His symptoms were so slight at this time that he was unwilling to have anything done.

*Second X-ray Examination* (Sept 18). Films were now taken, and although there was still no obstruction, the ulcer showed now as a large fleck in the mid-oesophagus.

Admitted to hospital, Oct 8.

*FIRST OPERATION* (Oct 12)—Janeway gastrostomy. No sign of abdominal spread.

*SECOND OPERATION* (Oct 19)—*Cervical dissection* of the oesophagus down to the arch of the aorta. Silver wire loop placed around it.

*THIRD OPERATION* (Oct 21)—Anaesthetic (Miss Faux), gas, oxygen, and ether, with cyclopropane.

*Torek oesophagectomy*. The approach was through the right pleura, the whole of the 6th rib was removed, the vena azygos major divided between ligatures, and the mediastinal pleura over the oesophagus divided. The oesophagus was mobilized. There were no malignant glands, but the growth was beginning to show white under the muscle-fibres. An apparently complete and adequate removal was secured 6 cm beyond, above, and below. The distal stump was crushed, sutured, and invaginated, two-thirds of the thoracic oesophagus with growth was removed, the cervical stump was brought up through the root of the neck and fixed over the sternum in the usual way. Water-seal drainage was employed for seven days.

*PROGRESS*—The patient made an excellent post-operative recovery. Subsequently various minor procedures were carried out to prevent stricture of the upper stoma due to sloughing. The distal stump of the oesophagus was also brought through the abdominal wall with a view to using it for constructing an ante-thoracic oesophagus later, as advocated by Wookey. While this was being considered, however, he developed a nodule



in the cervical oesophagus, and an enlarged liver He died 10 months after the resection

At autopsy there was a huge liver with umbilicated secondaries There were malignant glands along the whole posterior mediastinum There was a secondary the size of a cherry in the upper oesophageal stump The abdominal pre-aortic glands were involved No metastases in the lungs

#### Comments —

1 This case shows the importance of oesophagoscopy in addition to barium swallow, before excluding carcinoma, where the symptoms are strongly suggestive

2 This was the earliest cancer of the gullet I have had, diagnosed in the pre-obstructive stage In no case have I felt so satisfied of having resected cleanly and completely well beyond the growth, which could only just be seen from the outside of the oesophagus The removal of the whole distal oesophagus might have made a difference here The rapid longitudinal lymphatic spread and the apparently high biological malignancy of any cancers of the oesophagus are no doubt closely related

Case 4 — Mrs A C M, housewife, aged 56

Admitted July 14, 1944 Always had good health until a month before admission, when she noticed some difficulty in swallowing which was not very serious No loss of weight A short, alert, healthy-looking woman, who could still swallow most ordinary food with little difficulty Clinical examination negative

X-ray Examination Carcinoma involving lowest 2 in of oesophagus

Oesophagoscopy Exuberant neoplasm lower end of oesophagus (at 30 cm—a short patient) Histology Adenocarcinoma

OPERATION (July 19)—Left transpleural oesophagectomy with oesophagogastronomy, in one stage Anaesthetic (Dr Faux) Endotracheal tube, closed-circuit ether and oxygen, respiration 'controlled' during latter half of time The standard left-sided resection with oesophagogastronomy as later described, was then performed The lowest 2 in of oesophagus was a solid cylinder of growth, areolar tissue outside condensed but not adherent Two pints of blood was transfused during operation Condition at end of operation was very good Pulse 84

PROGRESS—Two days after operation she started regurgitating some "black fluid" every time she coughed, which proved to be stale blood and gastric contents (16 oz residue) and caused some anxiety It appeared that the post-operative oedema was enough to constrict the hole left in the diaphragm It was treated by gentle suction and washing out through a Ryle's tube twice a day On the fifth day, to spare her veins, a jejunostomy was done under a local anaesthetic and the opportunity taken to feel the gap in the diaphragm It was not unduly tight However, a large catheter was passed up into the thoracic stomach, with its lower end in the duodenum This helped to keep the dilated upper chamber drained till the stomach regained its tone The gastric contents steadily became cleaner, the emptying was studied by small barium swallows and as soon as it was satisfactory—on the ninth day—she was allowed to take fluids The drainage from the pleura was only 3 or 4 oz in all, and the intercostal tube was removed after two weeks as the discharge was clean The jejunostomy tube was taken out after three weeks She got up on the seventeenth day

Her wounds healed by first intention Discharged on Aug 20, 1944, taking full ordinary diet

She remained very well with no postural regurgitation, and doing her ordinary housework for about nine months She then developed a right recurrent laryngeal nerve paralysis, with nothing to account for it Six weeks later a mass appeared in the right posterior triangle of the neck She died with recurrences in the neck 14 months after the operation

Case 5 — J B, age 42, fishmonger

Admitted Aug 3, 1944 Onset with hiccup 10 weeks before admission, soon followed by difficulty and sub-sternal pain on swallowing solids, and the food sticking halfway down the breast bone Could still swallow a little fluid General condition very fair Thin, scaphoid belly B P 170/100 No physical signs

X-ray Examination Intrinsic obstruction distal third of oesophagus a little above diaphragm

Oesophagoscopy (Aug 5) At 37 cm is a carcinomatous ulcer Laterally mobile Biopsy showed tubular epithelial structure in a rather fibrous stroma

By Aug 8 he seemed to be getting nothing through, his pulse was small and rather rapid (90–100), and pyrexia (99–100°)—nothing apparent to account for this

FIRST OPERATION (Aug 9)—Local field block procedure Upper laparotomy

1 Exploration—no evidence of secondaries in belly

2 Large vessels—left gastric and vasa brevia tied and divided

3 Witzel jejunostomy, transomental

SECOND OPERATION (Aug 16)—Assistant, Mr Kirz Closed-circuit cyclopropane (Dr Faux)

Left thoracotomy through bed of 8th rib There was a little turbid fluid in the pleura A mass the size of a plum in the lower 2½ in of oesophagus, infiltrating the diaphragmatic hiatus Gullet was freed above and tape passed around it The diaphragm was then divided It was found that a good deal of plastic peritonitis had occurred (in one week) around the stomach, its final freeing involved a deal of delay The growth invaded the posterior mediastinum and the right pleura, and on removal left a gap in the pleura 1 × ½ in The margin of the hiatus also was removed in one piece with the oesophagus An end-to-side oesophagogastronomy was performed 1 in below aortic arch by the method described The patient died shortly after, apparently of circulatory failure resulting from respiratory failure and shock

Comments—At autopsy no cause was found for this patient's pyrexia except the rather large and rapidly growing cancer itself (Note the fluid in pleura) The right lung was partly airless from the open pneumothorax A tough and shaggy clot the size of a fig was found in the right auricle adherent to the auricular appendage, extending through the tricuspid valve into the pulmonary artery This was apparently ante-mortem and must have formed in the last hour of life, due to the failing respiration and circulation Whether a cure is ever to be expected in a case extending so far beyond the wall is doubtful But in a favourable subject the operation seemed worth attempting in view of the full palliation to be expected should he survive

The disadvantage of doing any preliminary operation on the stomach in a left transpleural oesophagectomy was amply brought home to me in this case As the diaphragm can be opened wide a one-stage procedure is quicker and better

Case 6 — P R, a metal-polish worker, aged 66

Admitted on Aug 4, 1944 Always healthy until four months before admission, when he began to get difficulty with swallowing A wasted, rather pale man, who could only swallow fluids

X-ray Examination Neoplastic stricture of middle third of oesophagus at the level of the bronchus (Fig 31)

Oesophagoscopy A carcinomatous stricture at 32 cm, papilliferous, reasonable lateral mobility Histology Squamous carcinoma

FIRST OPERATION (Aug 7)—Preliminary laparotomy No secondary spread Therefore the upper half of the stomach was mobilized A Witzel jejunostomy with a No 12 catheter completed this short operation

SECOND OPERATION (Aug 28)—Transpleural oesophagectomy under ether and oxygen anaesthesia, intra-tracheal tube, CO<sub>2</sub> absorber (Dr Faux) A right transpleural resection with oesophagogastronomy at level



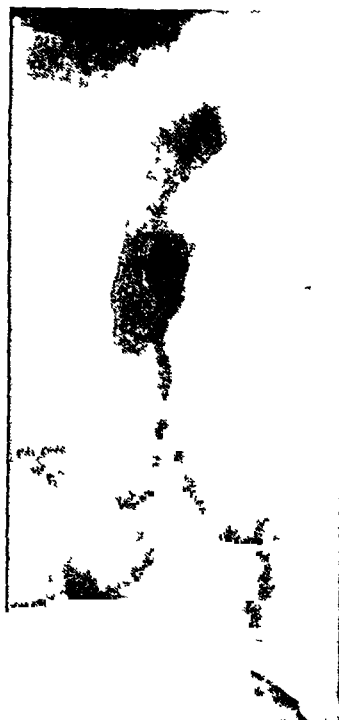


FIG 31—Case 6 Radiograph after opaque swallow



FIG 32—Case 6 Radiograph of chest, showing anastomosis high in right pleura. Note barium in stomach



FIG 33—Case 7 Radiograph after opaque swallow



FIG 34—Case 7 Radiograph of chest showing stomach in right pleura. Anastomosis at level of manubrium sterni

above vena azygos major was performed. The growth was found to extend from just below the vena azygos major for  $2\frac{1}{2}$  in distally. Several lymphatic glands were involved. Condition at the end of operation was good.

**PROGRESS**—Two days after operation some oedema developed at the bases of lungs, which cleared up after a pint of concentrated blood-serum (Blood-protein had fallen to 5.5 per cent). For the first fortnight he was only allowed sweets or ice by mouth. The jejunostomy was ample for his sustenance—he was getting milk and glucose, 4 to 6 pints a day, by this route. From the second day a Ryle's tube was passed into his stomach daily, the contents aspirated, and the stomach gently washed out. On the fourteenth day he began feeds by mouth, increasing steadily as gastric emptying was shown to be good by X rays (Fig 32). He was allowed to get up from the seventh day and was walking downstairs and into the garden on the twelfth day. The intercostal drain gave no trouble and was left out at the end of two weeks. There had been only slight infection, by *B. pyocyaneus*. On discharge he had a good appetite, was able to eat anything without discomfort. In the next three months he gained 34 lb. No regurgitation or other disability from his thoracic stomach. He has remained very well.

**Case 7**—F. H., a retired crane-driver of 67.

Admitted on July 18, 1945. Difficulty with solids seven months, liquids three months. Lost much weight (about 60 lb). Nine months ago he had been admitted to a sanatorium because he had a cough and some old calcified shadows in the right apex, but was discharged as a "pneumonitis". He could now only swallow milk or soft foods.

**X-ray Examination** Filling defect in middle third, about 1½ in long (Fig 33).

**Oesophagoscopy** Stricture at 30 cm admits a quill. Lateral mobility good. Biopsy Squamous carcinoma.

**FIRST OPERATION (Aug 17)**—*Mobilization of stomach and jejunostomy*. No secondaries. The stomach was mobilized as described later. Its upper reaches near the cardia, however, were not freed, as it is believed that separation here will only result in denser adhesions. A Witzel jejunostomy using a No. 12 catheter, which was surrounded by omentum. The abdominal wall was closed with fine nylon sutures.

**SECOND OPERATION (Aug 27)**—Assistant, Mr Kirz. Anaesthetic (Dr Parry Brown). Pentothal 1 g., closed cyclopropane with cuffed endotracheal tube. The right 6th rib from its neck to its cartilage was removed. On opening out the retractor the 5th rib cracked and the 7th was divided. The growth was easily palpable, extending downwards from the vena azygos major for 3 cm. There were no obvious glands involved. The oesophagus was then dissected free except for the deep aspect of the growth, where it was adherent to the left pleura, so its freeing was left till later. The stomach was then brought up as described, through the enlarged hiatus, with no great difficulty, but considerable new adhesions—very vascular—had already formed in the 10 days since the first operation. The lower oesophagus and stomach could now be lifted into the wound and so the cancerous portion dissected out cleanly. A piece of the adherent opposite pleura, however, came away with the growth. This had been anticipated and controlled respiration was maintained throughout from now till the chest was closed. The operation was completed as described, the stomach margins were sutured over the anastomosis rather firmly at the end, the patient remained in good condition throughout.

**PROGRESS**—The temperature only exceeded normal once after the operation, and the pulse remained of good volume and rate 80. Forty-eight hours after the operation he was coughing up yellow phlegm, however, and the next day, as there was some opacity of the bases, I did a thorough bronchoscopic cleansing of both bronchi,

leaving in 60,000 units of penicillin. As the prevailing bacterium was a pneumococcus he was given 60,000 units of penicillin daily via the cricothyroid membrane for three days. The phlegm rapidly diminished. On the evening of the eighth day he had a sudden cardiovascular attack with pallor, dyspnoea, and tachycardia. The pulse became rapid and the beats alternating. He improved during the night and progressed well thereafter. He was allowed fluids from the tenth day. The intercostal catheter came out after 10 days. The jejunostomy developed a bad leak, and kept him in longer. He was discharged very well and quite healed after two months. Fig 34 shows the stomach in right pleura and the anastomosis at the level of the manubrium sterni. He could swallow everything except lumps of meat—which stuck.

I inspected his stoma later. Quite healed. No sutures seen. It was the size of a little finger. Dilated from size 11 to size 18 bougie.

#### Comments—

1 It is interesting that adhesions had formed round the stomach in 10 days which took a good deal of separating, but did not seriously interfere with the second stage.

2 No satisfactory explanation was found for his sudden distress on the eighth day. It was probably a cardiac disturbance due to the vagal damage.

3 The narrowness of the stoma was most likely the result of the rather tight investing suturing of the stomach margins in this case.

## DISCUSSION

**Radiotherapy**—There seems little doubt that many cases of squamous carcinoma of the oesophagus are radiosensitive and in themselves should respond to X radiation.

L. J. P.-M., a frail little woman of 68, was admitted to the hospital in October, 1937. She complained of dysphagia and wasting 10 months. X-ray examination showed a filling defect  $\frac{1}{2}$  in long in the oesophagus at upper border of the manubrium. On oesophagoscopy I found a typical carcinoma with raised edges. Section showed a squamous carcinoma. Dr Bromhall gave her a course of X-ray therapy—4000 r in all. There was a good deal of general reaction. A year later she had gained 2 st in weight and looked very well. She had no symptoms. I oesophagoscoped her in 1943 and again last year. About 1 in below the cricopharyngeus she has a smooth supple crescentic web—the scar of the old lesion. The oesophagus at this point is the calibre of the little finger rather than the thumb, but otherwise there is no trace of her ever having had a cancer.

I am indebted to Dr Bromhall for her notes of the case.

This case, well and free of recurrence after eight years, shows what can be done in the upper third where the gullet is fairly superficial. Baum has had a case symptom free for six years and Pohle for seven years—the former died of metastases, however, after nine years. The adenocarcinomas of the lower end are not only inaccessible to adequate radiation, but often of a type, as in the stomach, which rarely responds. What of the squamous carcinomas of the middle third? About a third of them are of low differentiation, and by comparison with those of mouth and pharynx should be radiosensitive. But the crux of the problem here is that the growth is approximately 11 cm from the anterior chest wall and 10 cm from the posterior. Using 200 kv radiation the depth dose is only about one-third of the skin dose. It thus appears to be physically impossible to apply to the tumour an average

'sterilizing' dose without exposing the patient to more radiation than he can stand. On the other hand radium, both intracavitary and interstitial, has so frequently either had no effect or else has caused death from perforation into trachea, bronchus, or mediastinum that it has virtually been given up. With the exception of Guisez no one has claimed any cures, and even he now admits its value is palliative only. It seems, therefore, that in the upper third radiation is occasionally curative, in the middle third the growths are frequently of a radio-sensitive type, but they cannot be effectively treated because of their depth, whilst in the lower end the adenocarcinomas are both relatively inaccessible and relatively insensitive. As a palliative measure radiation can only justify itself if it renders a gastrostomy unnecessary. Although some have claimed that this can be achieved in half the cases, in my experience it is exceptional. I think the 'direct' irradiation of a growth found inoperable, through the operation wound, combined with lateral anastomosis (œsophagogastrostomy) is a treatment well worth pursuing.

**The Aims of Cancer Surgery**—The aims of radical cancer surgery are (a) To cure the disease, while (b) Rendering the patient's life useful and enjoyable—or at least bearable.

These two aims are always to be borne in mind by the surgeon and the effect of the operation explained to the patient beforehand. Frequently both aims cannot be fully achieved as, for example, in carcinoma of the rectum. Indeed in carcinoma of the pelvi-rectal junction it is still a matter of dispute even amongst surgeons as to how far the first objective should be compromised by the second consideration—i.e., the decision between a conservative removal and an abdomino-perineal resection will often depend on how unpleasant the patient considers a colostomy. The aim of palliative cancer surgery, however, is purely to alleviate the patient's symptoms—to reduce his discomfort. It may or may not prolong his life.

How do the various procedures for carcinoma of the œsophagus fare by these criteria? Palliative radiotherapy we have already claimed is only worth while if it is likely to preserve the swallowing. Gastrostomy is indicated when complete obstruction is impending in an inoperable carcinoma. Intubation with a Souttar's tube, now so seldom done, is in fact a much more satisfying palliative operation in the cases where the tube remains in position. As for the radical procedures it must be remembered that surgeons are so far still working on the purely technical problems of radical resection. It may well turn out that when these problems are solved, the cure rate will still be low. That is what has happened in the case of carcinoma of the stomach. If this should be so and the great majority of cases be destined to die of recurrence within a year or two, it is very important that the 'curative' operation which the patient has undergone should also be palliative when recurrence ensues, or at least that it should not actually increase his discomforts.

### THE LOWER END

Judged by the above criteria the present position with reference to carcinoma of the lower end is

very satisfactory. Not only does the resection with œsophagogastrostomy satisfy the postulates of Halsted for the removal of cancer, but it also gives the best possible alleviation of symptoms.

The early successful resections of cancer of the cardia (i.e., abdominal œsophagus) were done by the purely abdominal route (Voelcker, 1908, Kummel, 1910, Bircher, 1918). This entailed pulling down the lower œsophagus into the abdomen and anastomosing it to the stomach or jejunum. This procedure will always remain dangerous, as it must result in an anastomosis under tension. Nevertheless, as the piece resected was short (no doubt unduly so) about 40 per cent of the cases recovered. Sauerbruch, in 1905, published his ingenious *Einstulping* or intussusception operation for cancer here. He had no success, but Voelcker and Ohsawa had one each. Ohsawa's other cases, if limited to the cardia, were done by an extended abdominal approach, displacing the left lobe of the liver and enlarging the hiatus so as to enter the posterior mediastinum. In cases where the growth involved more than a centimetre or two of the lower œsophagus, however, he carried out several successful "thoracolaparotomies" with immediate œsophagogastrostomy. Although Biondi (1895) and Gosset (1903) had worked out the essential steps of transthoracic transphrenic œsophagogastrostomy, it was not until 1938, when Adams and Phemister described their successful operation in man, that the procedure became recognized as the standard method. Their work was based on animal experiments and the principles were confirmed by the experimental work of Noland Carter et al (1938).

**The Principles of Œsophagogastrostomy**—For growths of the lower end the left thorax is freely opened through the bed of the 8th rib. The phrenic nerve is paralysed. The œsophagus is mobilized, the diaphragm is freely slit from the hiatus outwards. The upper half of the stomach is mobilized and brought up into the pleural cavity. The following are essential—

- 1 Adequate resection *en bloc*
- 2 Removal of all tension from the suture line
- 3 Avoidance of the least soiling
- 4 An anastomosis which is end-to-side, two-layered, precisely stitched with interrupted sutures
- 5 Just as the sheet-anchor in abdominal anastomoses is the serous coat, so in the œsophagus it is the *mucosa* (see Fig 44). This is thick and comparatively strong
- 6 Water sealed drainage and early expansion of the lung

As for needles, Adams, Escudero, Aronsohn, and Shaw (1938) lost 4 out of 13 dogs through using a cutting needle for the anastomosis. The method of inkwell implantation was shown by Noland Carter's experiments to be uniformly followed by structure. This is a pity, as it promised to be a neater proposition than an edge-to-edge anastomosis.

The steps of abdominal surgery for cancer—viz, radical resection, mobilization to secure approximation without tension, anastomosis—have thus been successfully applied to cancer of the lower end by throwing the abdominal and thoracic cavities into one and mobilizing the stomach.

## THE MIDDLE THIRD

In the case of the Torek operation the position is very different. If there were a high prospect of cure then patients might face their discomforts with equanimity. However, a large proportion of cases are likely to recur early. These will therefore have undergone a formidable operation which not only has failed to cure, but has actually added to the misery of their remaining months. For they have probably had a gastrostomy earlier than they needed it and also had to suffer an additional stoma discharging several ounces of saliva on their chest wall every day. It thus seems imperative to devise an operation which shall both be surgically adequate and also preserve the swallowing. The simplest attempt to deal with this is a rubber tube joining the two distant stomata. This is uncertain, clumsy, and distasteful to some, too troublesome for others. The construction of an antethoracic *ersatz* œsophagus (jeuno-cutaneous) is another solution. This, however, means multiple operations lasting perhaps two years. It is very liable to blockage, infection, and fistulæ. The mortality from such reconstruction operations alone is considerable (over 20 per cent). The most weighty objection of all is that many of the patients will have died of recurrence before the operations can be completed. The number of Torek cases which have acquired a completed antethoracic œsophagus must be very small. Therefore surgeons have been trying to work out other procedures which constitute a different operation rather than the methods of modifying the functional results of the Torek described above. One is Garlock's recently reported method (1944) of transposing the upper œsophageal stump on to the outer side of the aortic arch, bringing up the stomach as in lower-end cases and making the anastomosis at the level of the arch. The drawback to this, in addition to the drawbacks inherent in the left pleural approach for these cases, is that the blood-supply of the upper stump, mostly descending from the inferior thyroids, is jeopardized. Moreover, the aortic arch interferes with the fixation of the stomach to the chest wall.

Hermon Taylor has applied the method which Kirschner tried for impassable simple stricture—mobilizing the stomach, bringing it up in a subcutaneous tunnel in front of the sternum to meet the œsophageal stump, and performing an anastomosis there. In the case of his which survived, the anastomosis broke down, leaving a gap which had to be bridged by a rubber tube. To complete the whole operation in one stage is a formidable undertaking, the security of the anastomosis seems none too good, and again the blood-supply of the upper œsophageal stump must cause anxiety. (Most surgeons who have done several Torek operations have seen the tip of an upper end slough.) Although in the last few years a return to basic principles has almost solved the problem of sepsis in intrathoracic anastomosis, the results are not so good as entirely to preclude further trials with exteriorization.

*Right or left pleural approach?* For growths of the lower end of the œsophagus and of the cardiac end of the stomach involving the œsophagus, the

cleft transpleural operation of resection with œsophagogastrostomy has become standardized. For growths of the mid-œsophagus also most surgeons have used the left transpleural approach. This is partly due to Torek's example, and partly due to the fact that the lymphatic spread is chiefly distal in the œsophageal wall, and the belief that as this is so the only way the gullet beyond the growth can be freely removed is through the left pleura. It has been claimed that the rational way to remove a carcinoma of the mid-œsophagus *with involved left gastric glands* is by a monobloc dissection through the left pleura and diaphragm. As Churchill and Sweet (1942) have pointed out, however, it will probably be found that few if any such cases are really operable. What is required in cases without intra-abdominal glandular involvement is removal of all the œsophagus down to the cardia. This is perfectly feasible through the right pleura, as first shown by Franklin at Grey Turner's clinic. Thus, if this last argument is met, the question of which side for the mid-œsophagus can be settled, as it should be, purely on considerations of approach.

The advantages of the right transpleural approach are—

- 1 A far better accessibility of the upper two-thirds of the thoracic œsophagus. (This is obvious on reference to the transverse sections of the thorax in any anatomy text-book.)

- 2 Only the vena azygos major has to be divided to lay bare its whole course.

- 3 The aortic arch (and to a large extent the descending aorta), instead of being an obstacle, becomes a safety barrier between the surgeon and the other pleural cavity. Instead of separating the growth bluntly and blindly from behind the arch, it can be dissected under full vision.

The side chosen for the operation should be that giving the better exposure. Therefore, to operate on the mid-œsophagus through the left pleura is as unanatomical as it would be to operate on the lower end through the *right* pleura. By adopting the method to be described the question of lymphatic spread in no way affects this general proposition.

## A NEW PROCEDURE FOR MID-THORACIC GROWTHS

Repeated dissections of the cadaver showed that the whole of the distal œsophagus could be removed through the right pleura. As an extension of this, dissections were made to see whether the stomach as well could be brought up through an enlarged hiatus. By first mobilizing it through the abdomen, it was found that the fundus could be actually brought as far as the apex of the pleura. Thus it seemed possible not only to remove the œsophagus, but also to complete the operation by an œsophagogastrostomy at any level demanded.

**Stage I**—An upper left paramedian laparotomy is done. The abdomen is carefully explored. If there are no metastases the greater curvature of the stomach is freed in its upper half. The vasa brevia, left gastro-epiploic artery, and the omentum are divided well away from the stomach, leaving a vascular arch attached to the greater curve. The gastro-hepatic omentum is then divided, again well away from the lesser curve, and the left gastric artery is tied and divided *near its origin*.

(Fig 35) To reduce inflammatory reaction and adhesions, fine silk should be used throughout and the most careful hæmostasis secured. Finally, a loop of gut about a foot down the jejunum is chosen and a size 10 catheter inserted by Witzel's method. This is brought out, surrounded by omentum, through the lower end of the wound. (If there are metastases present, all that is done is a Janeway gastrostomy.)

For the 10 or 15 days after the first stage every effort is made to improve the patient's nutrition by a

of tape are passed round the gullet to be used as 'guy-ropes' (Fig 37). The involved segment, together with any glands, is then slowly dissected free. Care must be taken to avoid opening the left pleura—a serious complication. There is no need to paralyse the phrenic nerve. The lower end of the œsophagus is gradually freed by retracting the diaphragm, dividing the branches of the vagi, and keeping it on the stretch with sponge-holders (Fig 38). The part in the œsophageal hiatus is then freed with the index finger. A specially devised sickle-shaped retractor (Fig 39) is now insinuated into

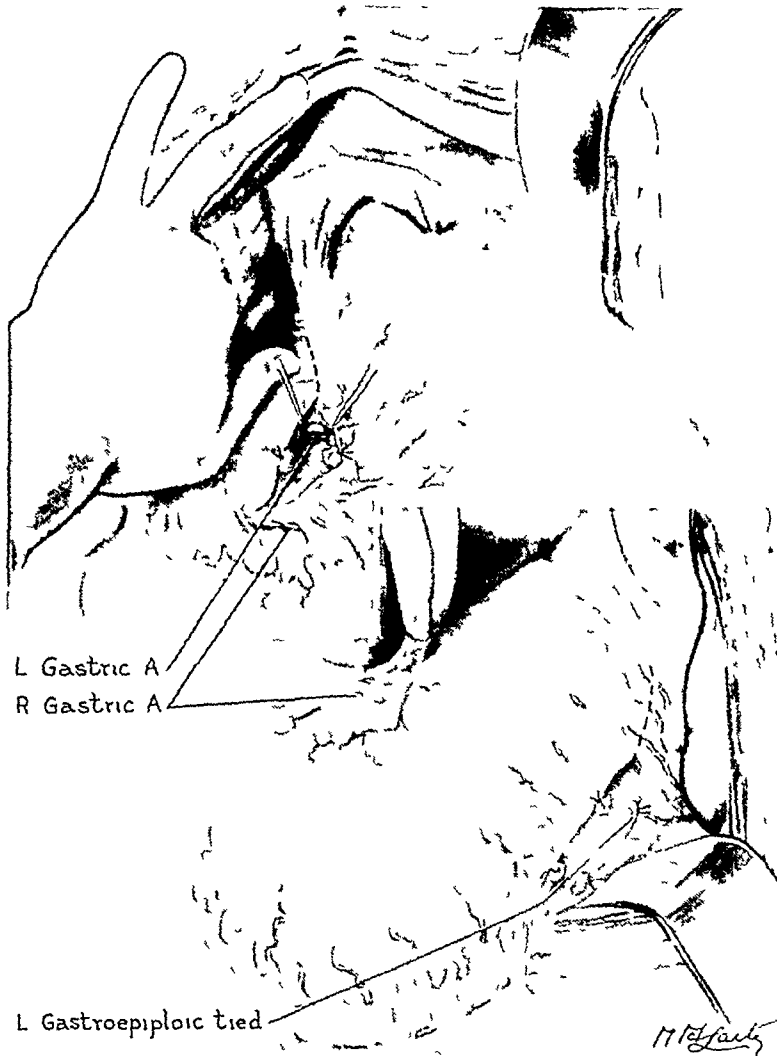


FIG 35—Left upper paramedian incision. The left gastric, left gastro epiploic vessels, and the vasa brevia are divided, leaving a vascular arch along both curvatures.

high-carbohydrate, high-protein diet, with extra vitamins. The jejunostomy makes this possible.

**Stage II**—With the patient in the left lateral position, and a sandbag under the chest, the whole of the right 6th rib from the neck to its cartilage is removed, and the chest entered through its bed (Fig 36, inset). If after careful examination the growth seems removable, the lung is packed forward and the vena azygos major divided between ligatures (Fig 36). The mediastinal pleura is then incised and just above and below the growth pieces

the hiatus. This instrument not only retracts and stretches the hiatus with its tapering end, but holds the diaphragm and underlying liver out of the way. As soon as the cardia is drawn up through the hiatus, the peritoneum is opened and then severed all round the circumference. By steadily drawing on the cardia, the fundus and eventually the body of the stomach are brought up into the pleura (Fig 40). Adhesions of varying strength will have formed in the interval since the first operation—they are separated. When the stomach is sufficiently mobilized so that the fundus reaches well above the

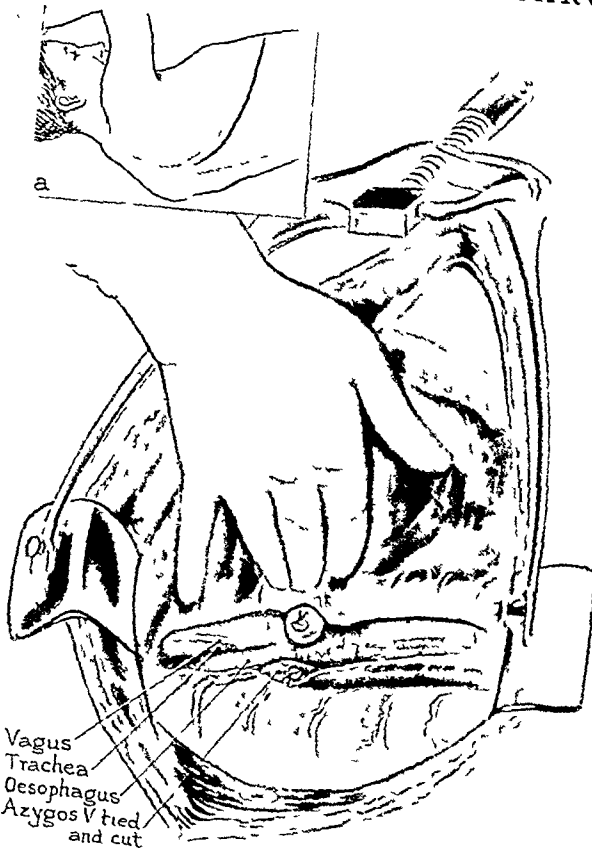


FIG 36—Right thoracotomy through bed of 6th rib. Vena azygos major has been divided and mediastinal pleura opened showing growth at level of left bronchus

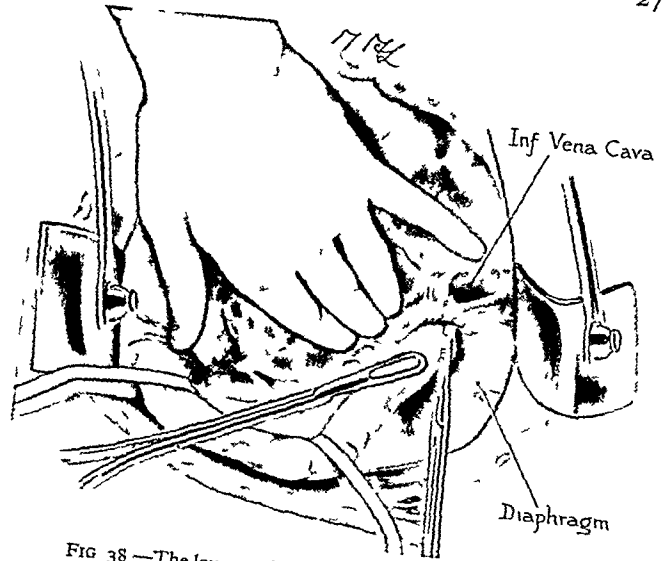


FIG 38—The lower end is gradually freed and drawn up by pledget dissection

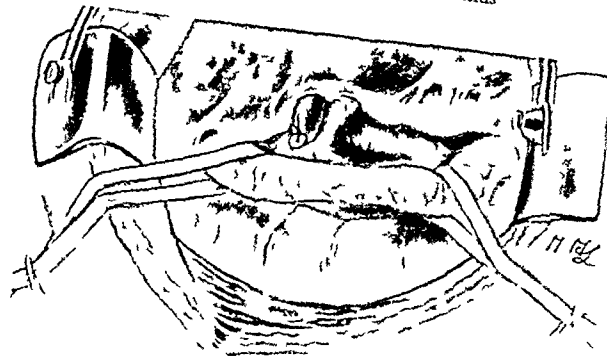


FIG 37—The oesophagus has been mobilized

growth, the oesophagus with a wedge of cardia is severed and the gap sutured and invaginated. (If any enlarged glands have now become evident along the upper part of the lesser omentum it is probably safe to extend the excision to include part of the lesser curvature, and still leave the fundus viable—the vascularity of the stomach is remarkable.) The next step of the operation is to prepare a gastric bed on which the oesophagus will lie. The upper end of the stomach is fixed in the angle between the vertebral bodies and mediastinum. Five or six interrupted silk sutures are placed along each edge—posteriorly fixing the stomach to the anterior spinal ligaments and anteriorly to the anterior cut edge of mediastinal pleura (Fig 41). The oesophagus is then laid

upon the stomach and the posterior layer of interrupted sutures is put in before cutting off the growth. A transverse incision is made in the stomach. Three points about this (a) It should be on the short side—it can easily be lengthened, but once too long it will make for a faulty joint, (b) Any bleeding points should be tied before proceeding—the time will be amply repaid by a clean field and accurate suturing, (c) Keep a small sucker with a hooked point just inside the stomach incision. The through-and-through layer also should be done with a fine needle, fine silk, close interrupted sutures carefully including the oesophageal mucosa in every suture. As shown in the diagrams (Fig 42), all knots are placed on the inside. The anterior sero-muscular sutures are then placed. Finally, if it can be done easily, the stomach edges or omental fringes are folded over in front of the anastomosis and lightly sutured (Fig 43). The enlarged hiatus does not need stitching up, it is only about the circumference of a wrist, three or four sutures are, however, placed between the stomach and its rim to prevent small gut passing through. 60,000 units of powdered penicillin is sprinkled around the anastomosis. A No 14 catheter is placed alongside the anastomosis, with a second hole cut lower down to lie just inside the pleura. This is brought out through the 9th intercostal space laterally, to drain under water.

The chest wall is sutured in layers. During the stitching up the anaesthetist endeavours to get the lung well expanded. Any air left is drawn out forthwith by suction to the catheter. Blood transfusion is given throughout the operation.



FIG 39—The special hiatus retractor

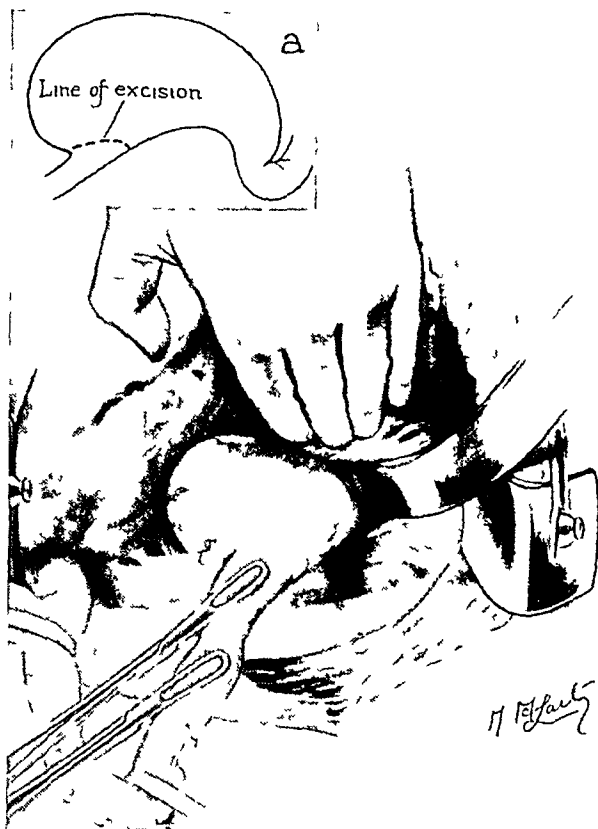


FIG 40—The hiatus has been dilated and the fundus and body of stomach are being drawn up. Inset (a) shows line of section of cardia

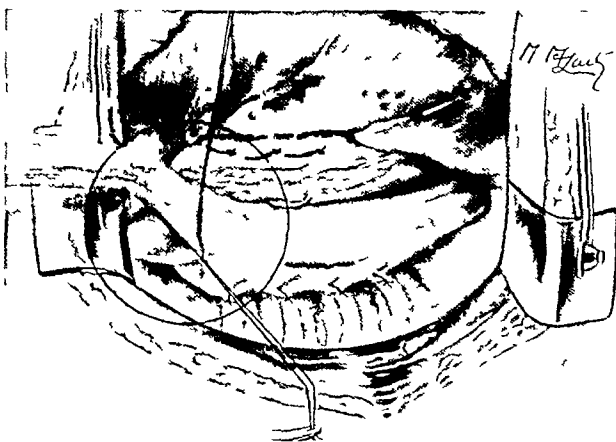


FIG 41—The making of the gastric bed and its fixation in the chest. The folded-back oesophagus is laid in position for the anastomosis

**Note** In these right-sided anastomoses, I have not crushed the phrenic nerve as the excursion of the diaphragm at the hiatus is small in contrast to that nearer the dome, which surrounds the stomach in left oesophago-gastrotomies. The great advantage of a working diaphragm during the first few days after the operation is obvious, provided it does not, on inspection, pull on the actual suture line

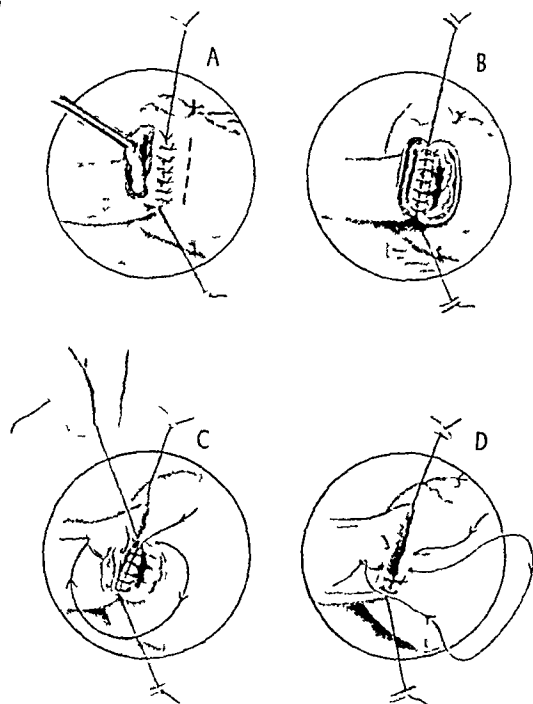


FIG 42—Details of the anastomosis. Note that the sutures are of fine interrupted silk. Each through-and-through suture includes the strong oesophageal mucosa which tends to retract out of sight. The knots are placed inside

If there is an appreciable amount of bronchial secretion, a careful bronchoscopic cleansing is done before the patient leaves the table

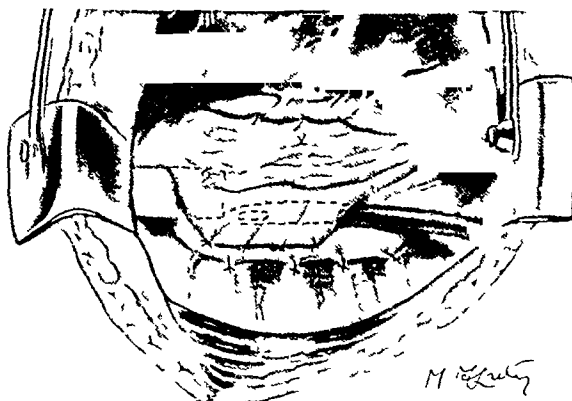


FIG 43—The stomach edge or an omental fringe is folded over in front of the completed anastomosis. The drainage catheter is fixed adjacent to the stoma

**Post-operative Care**—Blood transfusion may be continued after the operation if necessary. In most cases, however, not more than 2 pints of blood in all will be required. After this the needle should be removed from the vein and nourishment given by the jejunostomy tube—a far safer way. Thus the danger of oedema of the lungs through too much

# TREATMENT OF CARCINOMA OF THE OESOPHAGUS

29

fluid, of phlebitis and lymphangitis, is entirely removed. For the first 12 hours or so 70 per cent oxygen by BLB mask should be given. The patient is encouraged—and helped—to cough at frequent intervals. A bandage placed around the chest firmly, but not too tightly, is a great support (Much harm has been done by the plausible contention that restrictive bandages cause respiratory complications after chest and upper abdominal operations. The one essential in all such cases is that the patient should keep his bronchi clear. This

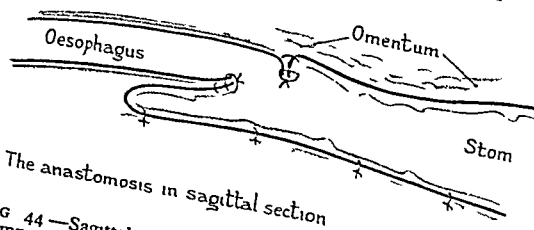


FIG 44—Sagittal section, looking from the right. Note the important layers—serous in stomach, mucosa in oesophagus.

he can do only by coughing. Coughing can only be done if the chest is firmly supported. The other great help to coughing is for the nurse to hold the sides of the chest really firmly whenever the patient needs to cough. If the bronchi are clear we need not worry much about the breathing, if they are not clear forced breathing only makes matters worse by aspirating the offending matter further down the bronchioles.)

A radiograph of the chest is taken every other morning. If any pneumothorax remains it is aspirated. On the third, seventh, and fourteenth days an ounce of barium emulsion is given to study the condition and emptying of the stomach by X rays. It takes a considerable time to regain its tone after such an operation, particularly one where both vagi are severed. A Ryle's tube is passed daily and the stomach emptied and gently washed out with a 10-c.c. syringe. As the patient is fed by jejunostomy nothing is given by mouth for 10 days except ice to suck and an occasional toffee to keep the mouth clean. After this time, guided by the aspirations and the X rays, one can start feeds and steadily increase them, provided stomach emptying is satisfactory.

If during the early days oedema of the bases of the lungs develops, I have found concentrated intravenous serum of more value than anything else. In any case the blood-proteins should be estimated on the third post-operative day, as a critical fall may occur about this time. A culture from the intercostal catheter is taken after two days. If it is sterile the tube may be occluded by a spigot and strapped to the chest. I think it is prudent not to remove the tube for two weeks, however. If all goes well the patient should be eating a full soft diet by the end of three weeks, and getting up and about before that time.

**Comments on the Operation**  
1. Absence of tension on all anastomoses—in-deed on all suture lines—is a basic requirement of surgery. In the operation described this is ensured

by actually fixing the stomach to the chest wall and merely apposing the oesophageal stump to it. No tension sutures are placed in the oesophagus—they are not necessary in this operation and, were they so, would be a danger in its friable wall.

2. A small, but important technical detail as the anastomosis is end-to-side, the layer likely to prove difficult from tension is the anterior oesophago-peritoneal. The corresponding posterior layer is merely between the oesophagus and the gastric bed in front. Therefore, so as to provide safe apposition to the stomach wall well up into the thorax—a little farther than the posterior, so that there is enough slack to place these sutures comfortably, (a) To use transverse mattress sutures for this layer.

3. Infection may occur in two ways. (a) By soiling during the operation, (b) By leakage after the operation. The utmost care must be taken by frequent suction, swabbing, and light clamping to prevent soiling. Leakage after the operation is entirely dependent on the technical security of the junction. Penicillin is worth using to counteract the soiling, but can hardly be expected to save the case with leakage.

4. Time. In an active, fit patient it is possible to do the abdominal and thoracic stages at the same operation, as the first stage need only take about half an hour. The main operation of resection with oesophagogastrostomy will take  $2\frac{1}{2}$  to  $3\frac{1}{2}$  hours. In poor-risk cases some time can be saved by not picking up and ligating every one of the numerous small vessels crossing or supplying the oesophagus, and compensating for the blood lost by an extra few ounces of transfusion. One hesitates to advocate so unsurgical a proposal, but it is certainly preferable to having to skimp any of the care and precision which the anastomosis itself demands. Another way to save a few minutes is to leave the forceps on the vessels of the chest wall during the operation. Instead of tying or coagulating, the handles are grouped together into three or four bunches and tied. At the end of the operation they are merely taken off—few of the bleeding points will start again.

5. Damage to opposite pleura. Several surgeons have referred rather casually to this accident and advised "covering the tear with a damp swab" or even "suturing the edges of the tear" before proceeding further. In fact, however, the sudden addition of the second pneumothorax, and that a valvular one, is the most serious trouble likely to occur during the whole operation. The increased respiratory embarrassment rapidly brings on circulatory failure. In one of the cases recorded actual ante-mortem thrombi formed in the right auricle. If a tear should occur certainly the best way to deal with it is immediate plugging with a wet swab and reliance on the anaesthetist's skill to carry out controlled respiration exclusively for the rest of the operation. The plugging by itself is capricious and is apt suddenly to allow access of more air, which cannot be expressed again. Any attempt at suture of the thin membrane is to make matters worse, quite apart from the fact that usually the growth cannot yet be lifted from its bed, and so give good access. Probably the best course, where the growth appears adherent to the opposite pleura, is merely



to dissect all round and carefully postpone further manipulation on the deep aspect. When the distal end of the œsophagus has been cut it can be lifted well up and the growth finally freed. At this stage, should a tear occur, it can be immediately plugged and the plug need not now be disturbed till the moment the chest is finally closed and both pleuræ exhausted.

### RETROSPECT AND PROSPECT

"Fear of the pleura will in a few years pass into the limbo of forgotten things, there to keep company with the fear of the peritoneum which for so long haunted the minds of surgeons." These words were written, not in 1943, but in 1903, by Gosset. He, moreover, went on to state that not only the transpleural transphrenic œsophagostomy worked out experimentally by him could be carried out by that route, but also total gastrectomy. One is tempted to dismiss such a statement as an over-confident and hasty prophecy based, as it was, on three bodies and a dog! It was all very well to belittle the dangers of transpleural operations, at a time when those dangers, physiological and infective, still meant a mortality of nearly 100 per cent. It is not surprising that much of the next 40 years was spent in devising ways of circumventing the dangers rather than facing them. Since surgeons returned to a frontal attack, progress has been rapid, and Gosset lived to see his prophecy vindicated before his death in 1944. The operative mortality in all the cases of œsophagectomy which Ochsner and De Bakey could collect up to 1940—a total of 191, was 72 per cent. Since then it has steadily fallen, in spite of the fact that an increasing number of anastomoses have been carried out, making the operation longer and more difficult. Garlock, in 1944, reported he had operated on 60 cases, with a mortality of 48 per cent. In 45 of these an anastomosis was done. Recently he reports that his mortality has come down to about one in three (Garlock, 1945). Sweet (1945) reports 90 cases of resection with œsophagostomy at Massachusetts General Hospital with only 16 deaths (18 per cent), their total mortality rate for all the transpleural resections, both œsophagostomies and total gastrectomies, was 21 per cent. Phemister (1945) has operated on 22 cases, with 8 deaths. It thus looks as if the operative mortality, in the hands of surgeons who are both adept at abdominal surgery and also used to working in the thorax, is going to settle well below 40 per cent. As for long-term results it is still early to judge, as nearly all the large series have been completed so recently, although we do know that the great majority have recurred within two years. Nevertheless the number of long survivors is gradually mounting. No one has yet had a patient live as long as Torek's original case—thirteen years. Garlock (1945), out of 76 resections, has 24 alive and well, varying from ten years to one month. Out of his 36 patients with squamous carcinoma 10 are alive and well, 4 of them over five years, 2 two and a half years, 2 one year. Of his 40 resections of the cardia (adenocarcinoma), all with anastomosis, 14 are alive and well, the period ranging from five and a half years down, the majority between two and three years. Sweet

(1945) tells me he has the following survivors out of a total of 84 operated on: 1 over five years, 1 over four years, 7 over two years. Noland Carter (1945), out of 8 successful resections, only had 1 live over two years. Phemister (1945) states that of his 14 operative successes, only 3 have lived over two years. His well-known first case (1938) is still alive and well. The other 2 lived three years, both dying of recurrence. Out of a total of 172 cases operated on in three American centres in the last few years with an operative mortality of 29 per cent there are 7 cases alive and well over five years, 21 over two years. As rather more than half the cases have been done in the last two years, a rough corrected figure would be a 5-year survival-rate of 9 per cent and a 2-year of 25 per cent.

We have come to realize that the Torek type of operation will possibly prolong the patient's life, and certainly prolong his misery.

As for the prospect, it is not entirely a fair one. We had been led to hope that the problem of cancer of the œsophagus was essentially a technical one. But as that gets solved, disquieting evidence is accumulating that this lesion is, in the main, of rather a high malignancy. Degree of malignancy, to the patient, is the length of time the disease takes to kill him; to the pathologist it is an opinion based on post-mortem findings and the appearance of the cells. For the surgeon, it may be defined as the liability to recurrence after apparently adequate removal. This is the practical criterion, and in a few years it will decide the long debate as to whether cancer of the œsophagus is of high or of low malignancy. In the meantime 2300 people in England and Wales develop cancer of the œsophagus every year. Our aim must be radical operation in more of the early cases and in fewer of the late ones. The hope of discovering some early symptom which would bring the cases to light before the obstructive stage is unlikely to materialize. In the minority of patients where pre-obstructive symptoms do occur (epigastric discomfort, retrosternal pain, a sore feeling in the back, cough) these are not clamant enough to take them to the doctor and not characteristic enough to suggest the diagnosis even if they did. We therefore have to fall back on dysphagia as *the* symptom. Is it too much to hope that before long the public will be taught that any disturbance of swallowing must mean seeing the doctor about it, that doctors will assume all such cases over 40 years of age to be due to cancer unless obviously due to something else, and that physicians and surgeons will insist that such growth is excluded only when both radiography and œsophagoscopy are negative? The early case means less sepsis, less malnutrition, an easier and quicker operation. (The late cases, doubtfully operable, will probably come to be treated by a by-pass operation, using fundus of stomach or jejunum according to the circumstances, perhaps combining the procedure with direct irradiation through the wound.) Early diagnosis should thus be rewarded by a reasonable operative mortality, good relief of symptoms, and at any rate a fair number of 5-year cures. It is disappointing that, for the moment, the outlook is not brighter. For no field in surgery presented more dangers and difficulties, in none was the challenge taken up

with more persistent endeavour in the face of repeated failures

# SUMMARY

1 A brief account of how the bold early experiments in œsophageal surgery were followed by decades spent in trying to circumvent rather than face the dangers, and recently by a return to straightforward resection with anastomosis

2 An account of 7 personal cases of œsophagectomy, with 5 recoveries

3 The principles of œsophageal resection with anastomosis for cancer of the lower end, and the difficulties of applying similar methods to cancers higher up

4 An account is given of a new operation of resection with immediate anastomosis for cancer in the middle third After first mobilizing the stomach by laparotomy, a right transpleural œsophagectomy is performed, the stomach being brought up through the dilated hiatus, fixed at any required level in the right pleura, and an end-to-side œsophago-gastrostomy performed

5 A review of what has been achieved and how it might be improved upon

I would like to thank my anæsthetists, particularly Dr Faux and Dr Parry Brown, for their enthusiastic and skilful help, and their equanimity, also my house surgeons and ward sisters for their unremitting post-operative care Cases 4 and 6 were shown at the Royal Society of Medicine, and I am indebted to the Honorary Editor of the *Proceedings* for permission to include them here

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# CHRONIC OSTEOMYELITIS, THE SEQUEL TO A GUNSHOT WOUND

By GEORGE PERKINS, M C, LONDON

STARTING as a localized acute inflammation, osteomyelitis due to a penetrating wound pursues one of five courses —

a The inflammation may die down within a reasonable time and never again trouble the patient. Probably this is the most frequent outcome. The body, by its defences, aided medically by drugs that inhibit the growth of organisms and surgically by drainage, smother the infection

b The acute inflammation may continue for a long time, and from its very chronicity acquire the appellation of chronic osteomyelitis. This, however, is not what we generally mean by

chronic osteomyelitis, and it is better to distinguish it under the separate title of *persistent acute osteomyelitis*

c The acute inflammation may subside, leaving behind a sinus which extends down into the interior of the bone

d The acute inflammation may die down and the wound heal, but later, after an interval of months or years, the acute inflammation recurs. We refer to these recurrent eruptions as *flares*

e The patient may have a chronic sinus and also be subject to recurrent attacks of acute inflammation in the bone

The problem, therefore, resolves itself into treating one of four conditions, namely (1) Persistent acute osteomyelitis, (2) A sinus, (3) Recurrent acute osteomyelitis (a flare), and (4) A sinus with flares

### PERSISTENT ACUTE OSTEO-MYELITIS

This is a medical and not a surgical problem. The inflammation persists because the body is unable to kill the attacking organisms or to prevent their multiplying, and surgery cannot influence the quality of the natural defences of the body. We surgeons want assistance from the pathologists and the chemotherapists. Let the pathologists tell us how to bolster up the natural defences, for it is by these defences that the infection is ultimately conquered, and let the chemotherapists give us a drug that taken by the mouth will penetrate via the blood-stream into the utmost recesses of bone. Penicillin is such a drug, but there is a limit to the time that it can be used because the patient revolts against being persistently jabbed with a needle.

It is true that surgery is of use in acute inflammation, by affording an exit to pent-up pus, as in the opening of an abscess, and by excising *in toto* an inflamed area, as in appendicectomy. And these successes have tended to make the surgeon forget his limitations. In osteomyelitis due to a penetrating wound there is nearly always adequate drainage, and surgery therefore is not required to give an exit to pus. Nor can we hope to excise the whole of the acutely inflamed bone without grossly infecting the surrounding tissues, the defences of which are known to be subnormal. We are forced to the conclusion that there is no surgical treatment for persistent acute inflammation of bone.

However, although the inflammation does die down at last, it may by its prolongation endanger the life of the patient. Moreover, other disabilities may be present that would render the limb of little use even when the osteomyelitis had subsided, for example, an ununited fracture, an unsuturable nerve lesion, stiff deformed joints, damage to main blood-vessels, wide destruction of skin. Therefore, in persistent acute osteomyelitis, amputation of the limb is often advisable, either to save life or because an artificial limb will be of more use to the patient than his own crippled leg.

### A SINUS

The acute inflammation of the bone may subside, leaving behind a sinus. A sinus is a nuisance because it condemns the patient to wear a dressing to protect his clothing, and because the smell from the discharge (particularly if the wound is secondarily infected by *B. proteus*) is often offensive, and patients often clamour for treatment in the belief that a surgeon can easily get a sinus to heal. Sometimes he can, more often he cannot. A sinus indicates the presence of a foreign body or sequestrum, which the patient is endeavouring to wash out of his body, or (b) the continuation of a mild chronic infection of the bone. And it is often difficult for the surgeon to decide which of these two conditions confronts him. A radiograph may give valuable

information, as it reveals metallic foreign bodies and often sequestra. It is not, however, conclusive, for the foreign body may not be opaque (an unabsorbable suture, for example) and not all sequestra are denser than the surrounding bone.

As a rule, a sinus heals after the removal of a foreign body or sequestrum, and whenever the radiograph reveals either, the surgeon should operate. When the radiograph reveals neither, it is justifiable to operate once, and once only, for if the sinus recurs (as so often happens) further operations are unlikely to be any more successful.

It is important for the surgeon to decide why he is operating, because the type of operation differs in the two cases.

**Operation when a Sequestrum or Foreign Body is Present**—The aim of the operation is the removal of the sequestrum or foreign body. A probe is inserted into the sinus and the surgeon cuts straight down (anatomy permitting) on to the point of the probe. If this has entered bone, a small coffin-shaped piece of cortex is removed and discarded, revealing a cavity within which the sequestrum is lying. The sequestrum is picked out and the wound is lightly sewn up without drainage. No attempt is made to excise the track or to obliterate the bone cavity. Should the wound later show signs of inflammation the stitches are removed and the wound allowed to gape. The object of the operation is the removal of the cause of the irritation, and if this is achieved the sinus closes.

The question arises—at what time after the onset of the osteomyelitis should one remove sequestra? I believe this should be determined not by the length of time that has elapsed but by the cessation of acute inflammation in the bone. But how are we to know whether the bone is still acutely inflamed? There are so few signs of active inflammation of bone. The radiograph does not help, and provided the products of inflammation are not under tension there is no pain. In fact, the only clinical sign is tenderness of the bone. However, with osteomyelitis due to a penetrating wound there is always infection of the soft tissues as well as infection of the bone, and inflammation of the soft tissues can be detected clinically. And we may assume that when the defences of the body have overcome the infection of the soft tissues they have simultaneously overcome the active infection in the bone. If the soft tissues are still inflamed, so is the bone, if the soft tissues are no longer inflamed we may assume that active inflammation has also subsided in the bone. In my judgement, sequestrectomy should be deferred until the soft tissues around the sinus are free of heat, redness, swelling, and tenderness. As soon as this inflammation of the soft parts has subsided sequestrectomy can be safely undertaken. One need have no fear that the sequestrum will not be loose, because sequestra are already detached by the time they are disclosed by radiographs.

**Operation when there is No Sequestrum or Foreign Body**—In this case the object of the operation is the removal of all infected bone, the assumption being that the sinus exists to give an exit to the products of the continuing inflammation. The plan of operation is entirely different from that of sequestrectomy.

The sinus track is excised and as much of the surrounding fibrous tissue removed as is safe, having regard to the presence of main nerves and vessels. A large extent of bone is exposed subperiosteally, and up to a half of the circumference of the cortex is chiselled away piecemeal until healthy bleeding bone is reached. Sometimes the whole diameter of the bone is permeated with chronic inflammatory tissue, if this is so, the operation will probably fail, since the aim of the operation—the complete removal of all infected bone—cannot be attained. Care must be taken not to fracture the bone, and the limb should be well supported on sandbags during the operation to minimize the risk. The walls of any cavity should be removed, for unless the soft tissues can fall in and obliterate all dead spaces the operation is unlikely to succeed because the void will be filled with blood-clot which acts as an incubation chamber for the growth of organisms, whereby the infection is perpetuated. The operation entails hard work and much chiselling.

So far, so good. The surgeon has succeeded, as he hopes, in removing all the infected bone. However, his task is only half done, he now has to prevent the bone from getting reinfected either by its own organisms, some of which of necessity remain in the wound, or by new organisms introduced from outside.

In the old days reinfection was taken for granted and an immediate acute inflammation of the bone was assumed to be inevitable, and in order to prevent further necrosis from this new bout of inflammation free drainage from the bone was considered imperative. Accordingly, the wound was lightly packed with gauze soaked in paraffin, and this was renewed every few days. The result was that a new infection was introduced and the operation failed to cure the sinus. The recent war has changed this procedure, for it has taught us that it is well-nigh impossible to prevent exposed tissues from becoming infected, however carefully the dressings are done, it has also given us an antiseptic harmless to the tissues. Modern treatment is based not on the inevitability of reinfection, but on the vital necessity for avoiding it.

After the removal of the dead bone, therefore, the wound is sprayed with penicillin, care being taken not to overlook small crevices and recesses, and the wound is sewn up. Some surgeons leave tubes reaching down to the bottom of the wound through which penicillin in solution can be squirted from time to time. This does not appeal to me, as I cannot believe the fluid can circulate freely and permeate the whole wound, as it can when injected into one of the natural cavities of the body. On the other hand, any channel of communication between the outer world and the depth of the wound is an invitation to organisms to enter.

This procedure—thorough spraying of the walls with penicillin, followed by immediate suture of the wound—is feasible when the bone is lying at some depth from the surface. But when the bone is subcutaneous the wound cannot always be closed for lack of healthy skin. It is futile to try and obliterate a gap by sewing the edges of the skin under tension, the suture line invariably breaks down. To replace lost skin, skin must be imported. Three methods

are under trial (a) Covering the raw area with a Thiersch graft, (b) Raising at a previous operation lateral skin-flaps ready to be swung across the gap, and (c) Preparing beforehand a full-thickness skin-graft and transplanting one end of it some weeks before the bone operation is undertaken.

It sometimes happens that the radiograph shows a foreign body in the soft parts and old osteomyelitis, and the surgeon is not sure whether the sinus is caused by the foreign body or by smouldering inflammation in the bone, and in consequence is undecided which type of operation to perform—whether a simple removal of the foreign body or a resection of the diseased bone. In these circumstances useful information is sometimes obtained by X-raying the area after the injection of lipiodol into the sinus. When the opaque track leads towards the foreign body it is a safe assumption that the foreign body is the cause of the sinus, and the simple operation is indicated, when the track leads into the bone the bone should be excised.

These two operations—sequestrectomy and bone excision—are both designed to get rid of a sinus. And I have said that if the sinus recurs after one bone excision, no further operation should be attempted in the hopes of getting the sinus to heal. There is, however, one exception to the rule that a sinus should not be operated upon after a bone excision has failed: another operation is justified if the discharge from the sinus stinks. A spring-cleaning operation, at which as much infected tissue as possible is removed, often gets rid of the secondary infection and therefore of the smell. But the patient should be made to understand that the operation aims only at getting rid of the smell, otherwise he will be disappointed when the sinus fails to heal.

### RECURRENT ACUTE OSTEOMYELITIS (A FLARE)

These flares, although associated with local signs of inflammation and often with intense pain, are peculiar in that they are not accompanied by severe or lasting toxæmia. The patient's temperature is raised and he may feel ill, but this phase passes off quickly, and within a few days his health is restored. In this respect a flare is not unlike a bout of malaria.

There is no accounting for these flares, and no known method of avoiding them. A patient may not have had any symptoms for years—perhaps 20—then, after a blow or excessive muscular exertion, or sometimes for no obvious reason, the wound flares. The rapidity and ease with which these flares are overcome show that the body has a strong defence, but seemingly the defence is not strong enough to prevent an attack, although capable of smothering it when it occurs. Immunizing the patient with vaccines has not met with any success, indeed, an interesting fact is that once the patient starts having flares he may have several in quick succession in spite of not having had any trouble for years previously.

The inflammation may or may not be confined to the bone. Clinically, the skin, the deep tissues around the bone, or the bone itself, may appear to be the principle (or sole) site of the inflammation. Of particular interest is the subcuticular inflammation

that spreads far up and down the limb and resembles an erysipelas. An attack of erysipelas of this nature is a good omen, since it seems to confer an effective immunity lasting some time.

Treatment consists of rest, and the patient should be kept in bed. Locally, hot poultices are soothing. Surgery is not indicated unless an abscess forms. An abscess should, of course, be opened, but there is no urgency. The longer the abscess can be left, the nearer it approaches the surface, and the smaller need be the opening. Meanwhile, the patient is receiving self-immunization. It is sufficient to give an exit to the pus through a small incision, and to leave the wound open, it is not necessary (or advisable) to establish prolonged drainage. As a rule, the wound heals within a week or two, and the patient's condition is then much what it was before the flare. Even when an abscess arises within the bone, the bone rarely needs to be touched because cloacæ allow the pus to escape from the bone. Only exceptionally, when a high temperature and severe pain persist, is exploration of the bone called for.

### A SINUS WITH RECURRENT FLARES

These cases as a rule defy treatment. The sinus indicates a persistent grumbling inflammation, and the flares indicate that the bone is riddled with organisms that are potentially active. Operation rarely does any good, particularly when the end of a shaft is involved, where for anatomical reasons an adequate removal of diseased bone is not feasible.

Most of these patients have undergone many

extensive bone operations without any benefit, each one invaliding them for many months. Excluding an operation on the bone, there are two courses open to the patient: one, to accept his lot and to be resigned to periodic flares which will keep him from work for several weeks once or twice a year, and the other, to lose his limb. Many a pensioner of the last war is to-day thankful that he was at last persuaded to have his leg amputated.

Under penicillin it is usually safe to do a definitive amputation at a seat of election, in spite of infection in the bone lower down.

It remains to be stated that penicillin has not in my experience been of any benefit in preventing flares or in healing sinuses. Patients with chronic osteomyelitis willingly submit themselves to a trial of this treatment, and such is the faith of human nature that most of them declare that they have derived benefit from penicillin, sometimes even after the first injection. But to a sceptical observer it is difficult to see any change in the chronic osteomyelitis.

As surgeons, we want to know what surgery has to offer in the treatment of chronic osteomyelitis. Surgery is useful—

- 1 To remove a sequestrum
- 2 To excise a whole area of diseased bone, if that is possible
- 3 To get rid of an intolerable smell
- 4 To open an abscess

In other words, the four indications for surgery are a sequestrum, a sinus, a swelling, and a smell.

## A STUDY OF THE FATE OF NERVE HOMOGRAFTS IN MAN\*

By R. BARNES, P. BACSICH, G. M. WYBURN, AND A. S. KERR\*

In 1920 the Medical Research Council reported "nerve-grafts should only be adopted as a substitute for end-to-end suture in those very rare instances where it is absolutely impossible to bring about direct approximation." Interest in nerve-grafting was revived in 1932 when Ballance and Duel (1932), recorded the successful repair of facial-nerve injuries by autografts.

A fair proportion of nerve homografts are successful in cats (Bentley and Hill, 1936) and rabbits (Sanders and Young, 1942, and Bacsich and Wyburn, 1945, unpublished results), while Bentley and Hill (1940), after the repair of the external popliteal nerve of monkeys by a 3-in. nerve homograft, were able to elicit a satisfactory motor response on electrical stimulation of the nerve, and in some cases observed large numbers of nerve-fibres throughout the length of the homograft. Moreover, in man, regenerating nerve-fibres may penetrate some distance into, or even traverse the entire length of, the graft, and there appears in most cases to be a satisfactory vascularization of the graft. Recent accounts (Sanders, 1942, Seddon and Holmes, 1944, Spurling, Lyons, Whitcomb, and Woodhall, 1945)

stress the unqualified failure of the nerve homograft in man. The present report on the results of 8 cases of human nerve homografts once more confirms what can now be regarded as the normal expectation of the complete failure of this method of repair of gaps in the large nerves of the limbs.

Therefore, although from the standpoint of the surgeon the nerve homograft should be regarded as an incontrovertible failure, the experimentalist is tempted to further investigation by the tantalizing histological picture of partial success. The problem of the nerve homograft is not an isolated one, but part of the wider question of tissue reaction to grafts in general. The purpose of this account is therefore twofold. First, to add if need be further evidence to discourage, for the present at any rate, the use of nerve homografts for the repair of the large nerves of the limbs in man, and secondly, to study the late condition of nerve homografts in the hope that the accumulation of such knowledge will aid in the understanding of factors which determine its inevitable failure—a necessary preliminary to attempt to combat or eliminate such adverse factors. "Es muss unsere Aufgabe sein, den Gründen für das Misslingen der Operation nachzugehen und die Bedingungen des Erfolges klarzustellen"—Eder (1919).

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## MATERIAL AND METHODS

There are 8 cases of nerve homografts involving the large nerves of the limbs. In 3 of these the resected grafts were sectioned both transversely and longitudinally at 10 $\mu$ . Three separate sets of transverse sections were collected from both the central and peripheral ends of each block—one stained with a modified protargol method, one with



FIG 45—Case 1. Transverse section of central stump. Numerous medium-sized bundles, some of which are rather sparsely populated. Marked interfascicular fibrosis (Modified protargol method) ( $\times 12$ )

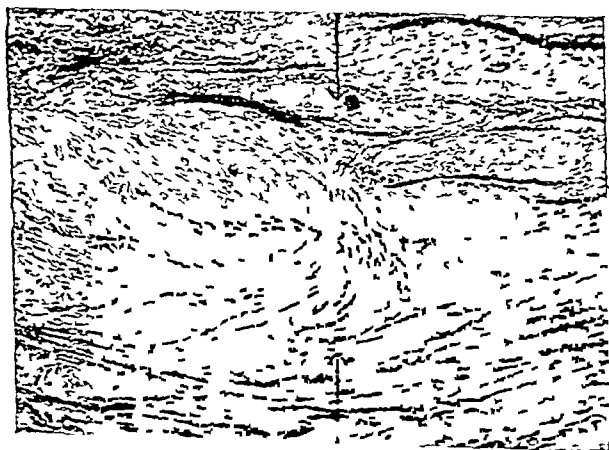


FIG 46—Case 1. Junction (marked by arrows) of central stump (left side) and graft (right side). Nerve fibres cross the suture line. There is considerable irregularity and criss-crossing at junction (Modified protargol method) ( $\times 42$ )

hæmalum and eosin, and the other with a modified Weigert stain. Two series were made of the longitudinal sections—one stained with protargol and the other with hæmalum and eosin. Occasional transverse and longitudinal sections (5 $\mu$ ) were stained by Mallory's or Pasini's triple stain. Clinical histories of these 3 cases are given in detail. The main features of the remaining 5 cases, in which there was only a limited histological study of the grafts, are summarized in Table I.

Case 1—A soldier, R. G. R., aged 28 years, sustained an adduction injury to his left knee, due to a motor cycle

accident on June 26, 1941. The lateral ligament of the knee was ruptured and there was a severe traction injury of the lateral popliteal nerve.

On Aug. 8, 1941, he was admitted to Winwick Emergency Hospital with a complete lesion of the lateral popliteal nerve. At operation on Sept. 1, the nerve was found to be involved in a mass of scar tissue at the level of the head of the fibula. Successive sections were made of the proximal end of the nerve to a point 10 cm. above the head of the fibula, but even at that level most of the nerve consisted of fibrous tissue, apart from a few bundles running to the ramus communicans fibularis. In view of these findings it was obvious that an end-to-end suture could not be performed with any hope of success, and it was decided to insert a homograft at a second operation.

On Feb. 21, 1942, 240 days after injury, the nerve was re-explored and a further 7 cm. of the central stump was resected before healthy nerve-bundles were encountered. There was now a gap of 18 cm. between the two ends of the nerve. This gap was bridged by a homograft removed from the external popliteal nerve of a patient who had died four hours previously. The suture was performed with stainless steel wire of a diameter of 0.0018 in. The graft was of smaller diameter than the recipient nerve and only about 75 per cent of the nerve-bundles at the proximal suture line were in contact with the graft. The blood group of the donor was unfortunately not determined. The post-operative convalescence was uneventful and the patient was discharged three weeks later, wearing a toe-raising spring.

On Feb. 9, 1943, he reported for review. A firm cord was palpable behind the knee in the line of the graft, pressure over it produced no tingling in the foot. There was no evidence of any sensory or motor recovery.

On Feb. 11, 355 days after insertion, the graft was re-explored under local anaesthesia. The graft was



FIG 47—Case 1. Transverse section of proximal end of graft. There are about 12 fair-sized bundles, most of them fairly well populated (Modified protargol method) ( $\times 12$ )

identified without difficulty, it was much firmer than at the time of insertion and felt like tendon. There was a firm neuroma at the proximal suture line. The graft was more adherent to the surrounding soft tissues than was the central stump. There was no sensory or motor response on stimulating the graft with a faradic current, but a powerful sensory response was obtained at the proximal suture line, which could easily be identified by the presence of the wire sutures. The entire graft, with a portion of central and peripheral stumps, was excised.

## HISTOLOGICAL EXAMINATION—

Central Stump—There are about twelve medium-sized bundles and one or two smaller ones (Fig. 45). The bundles, some of which are rather sparsely populated,

contain myelinated and non-myelinated nerve-fibres. The Weigert stained sections show considerable numbers

of thinly myelinated fibres. There is marked inter-fascicular fibrosis.



FIG 48—Case 1. Transverse section of graft below level of nerve-fibres. Varying degrees of necrosis in fascicles surrounded by mass of dense fibrous tissue (Hæmalum and eosin) ( $\times 15$ ).

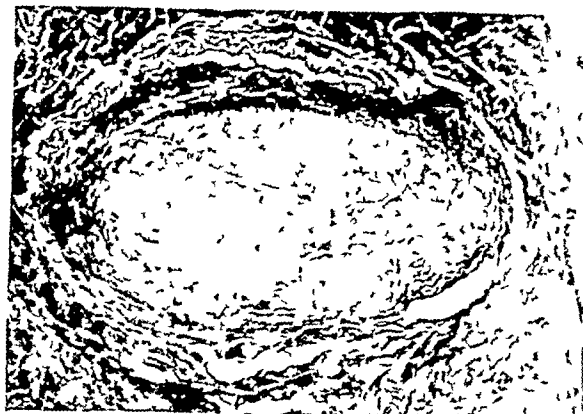


FIG 49—Case 1. Transverse section of graft at a slightly lower level than Fig 48. Well preserved perineurium. Complete necrosis of intrafascicular contents (Hæmalum and eosin) ( $\times 95$ ).

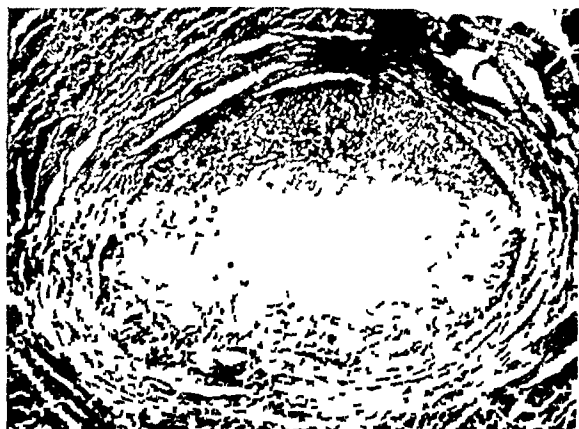


FIG 50—Case 1. Transverse section of graft. Early fibrosis. Mass of necrotic tissue in centre of a fascicle is enclosed by proliferating cellular fibrous tissue (Hæmalum and eosin) ( $\times 95$ ).



FIG 51—Case 1. Transverse section of graft. Late fibrosis. Necrotic mass inside fascicle is more or less completely replaced by cellular fibrous tissue (Hæmalum and eosin) ( $\times 95$ ).



FIG 52—Case 1. Transverse section of graft. Early collagenization. Cellular fibrous tissue inside fascicle is gradually replaced by increasing amount of collagenous fibres (Hæmalum and eosin) ( $\times 95$ ).

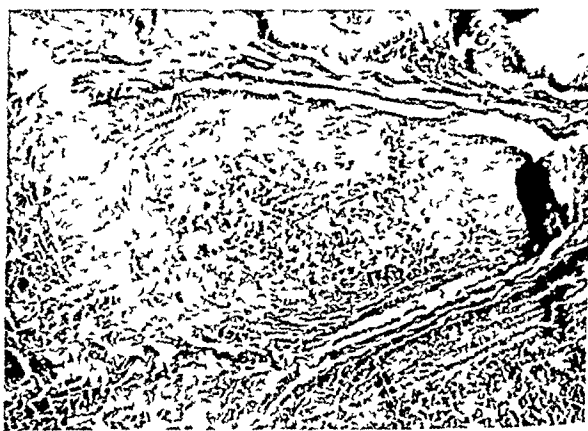


FIG 53—Case 1. Transverse section of graft. Late collagenization. Most of the fascicle is replaced by dense connective tissue (Hæmalum and eosin) ( $\times 95$ ).



**Graft**—Nerve-fibres cross the suture line into the graft and at the junction show considerable irregularity and criss-crossing (Fig 46). The nerve-fibres extend into the graft for a distance of 25 mm. In the proximal sections they occupy twelve fair-sized bundles (Fig 47) which decrease in number distally. There are myelinated fibres present to within a few millimetres of their termination. There is some endoneurial fibrosis of the fascicles but no marked thickening of the perineurium. The nerve-bundles are set in a mass of dense fibrous tissue. More peripherally the histological appearances vary in different parts of the graft, but in no definite order. Immediately distal to the innervated portion most fascicles show necrosis (Figs 48, 49). In the centre of the bundle there is a mass of disintegrated tissue which may be entirely structureless or preserve the endoneurial framework, and this necrotic centre is enclosed by a cellular fibrous tissue (Fig 50). The bundles may be clearly defined from the surrounding dense fibrous interfascicular tissue by a thickened perineurium or the

70 per cent of the bundles in the proximal nerve-stump were in contact with the graft. The blood group of the recipient was 'A' and of the donor 'O'.

In early February, 1942, the patient applied for repatriation, but before leaving hospital he was anxious



FIG 55—Case 2. High-power view of area in Fig 54 enclosed in square. Normal proportion of myelinated (surrounded by a halo) and non myelinated fibres. Slight degree of intrafascicular fibrosis, manifested in the increased thickness of endoneurial septa. (Modified protargol method) ( $\times 135$ )

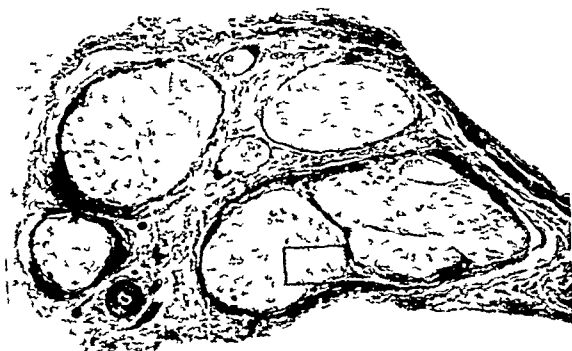


FIG 54—Case 2. Transverse section of central stump. Observe a number of large and some smaller bundles of normal appearance. There is only a moderate degree of interfascicular fibrosis. (Modified protargol method) ( $\times 135$ )

perineurium may be indistinguishable from either extra- or intrafascicular fibrous tissue and in consequence the fascicles are imperfectly demarcated.

In the same section of the graft there are fascicles with central necrosis, fascicles completely filled by necrotic tissue, and fascicles occupied entirely by a fibrous tissue which may be cellular or in process of collagenization (Figs 51–53). In the most distal part of the resected tissue (thought to be the peripheral stump) there is no evidence of nerve-bundles whatever and the sections consist of dense scar tissue. In view of the number of nerve-bundles present in the part of the peripheral stump resected at the time of the graft operation, it seems unlikely that this distal part is the peripheral stump.

**Case 2**—A French soldier, A. M., aged 39 years, was wounded in the left upper arm on May 27, 1940. He sustained an extensive soft-tissue injury, with a complete lesion of the radial nerve. On Dec 4, the nerve was explored. It was surrounded by dense fibrous tissue for a distance of 6.5 cm and a neurolysis was performed.

On July 11, 1941, the patient was admitted to Winwick Emergency Hospital. As there was no evidence of recovery the nerve was re-explored on Oct 2, 493 days after wounding. The damaged portion of the nerve was extensively scarred and 9.5 cm were resected before obvious bundles were reached. The gap was bridged by a homograft taken from the radial nerve of a patient who had died four hours previously. The graft was held in position by three fine linen thread sutures, at the proximal junction, and four at the distal junction. The graft was of smaller diameter than the nerve-trunk and only about

to have a more powerful grip. It was agreed that the graft should be re-explored under local anaesthesia, and that if the prospects of recovery were unfavourable a tendon transplantation should be performed at the same time. The operation was performed on Feb 19, 140 days after the insertion of the graft. The graft was

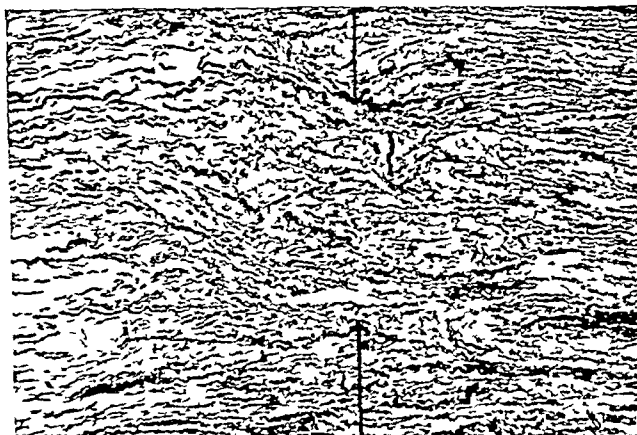


FIG 56—Case 2. Section through proximal suture line (marked by arrows). Central stump to the left, graft to the right. Considerable but not excessive, irregularity and criss-crossing of nerve-fibres at junction. (Modified protargol method) ( $\times 42$ )

identified without difficulty, it was firmer than at the time of insertion and adherent to surrounding tissues, but not to the same degree as in some of the older grafts. There was a neuroma 1 cm in diameter at the proximal suture line. Electrical stimulation of the graft produced no sensory or motor response. Part of the graft and 2 cm of the central stump were removed for histological examination.

#### HISTOLOGICAL EXAMINATION—

**Central Stump**—There are a number of large bundles, of normal appearance (Fig 54), with myelinated and



non-myelinated nerve-fibres (*Fig 55*) Towards the proximal suture line, however, there is some evidence of Schwann-cell proliferation

**Graft**—Nerve-fibres cross the suture line (*Fig 56*) and penetrate the graft for a distance of 12 mm. Distal to this point the fascicular contents are largely necrotic (*Fig 57*). Much of this necrotic tissue shows the ghost of the original connective-tissue framework consisting of a network of more deeply staining endoneurium enclosing nerve-tubes ballooned out by the swollen



**FIG 57**—*Case 2* Transverse section of graft distal to the point reached by the nerve-fibres. Fascicular contents are largely necrotic. All fascicles, with the exception of a centrally placed one, show sickle shaped cellular proliferation on their outer segments (Haemalum and eosin) ( $\times 15$ )

myelin sheath (*Fig 58*). In the more peripheral parts of the graft there are a number of necrotic fascicles forming a ring in the middle of the sections. The interfascicular tissue in the centre of this ring is necrotic, likewise the



**FIG 58**—*Case 2* High power view of area in square in *Fig 57*. Remnants of necrotic endoneurium and ghosts of ballooned-out myelin sheaths. Perineurium forming the inner half of circumference (bottom part of picture) is necrotic, that on the outer half (top part of picture) is healthy, with well marked nuclear staining. Observe sickle shaped cellular mass inside healthy perineurium (? survival of graft, or invasion by host connective tissue) (Haemalum and eosin) ( $\times 75$ )

perineurium forming the inner half of the circumference of the fascicles. The perineurium forming the outer half of the circumference of the fascicles appears healthy and proliferated, with well-marked nuclear staining. Immediately adjacent to this healthy perineurium a sickle-shaped mass of cellular tissue occupies the outer segment of the fascicles. This cellular tissue is quite distinct from the interfascicular fibrous tissue and is

clearly marked off from the circularly disposed perineurium. The abrupt transition from the interfascicular tissue to perineurium, and the definition of the perineurium from the sickle-shaped cellular mass occupying the outer part of the fascicles, is difficult to reconcile with the assumption of an invasion of the fascicles by the fibrous tissue of the host. The alternative conclusion is that there is survival and active proliferation of the original endoneurial connective-tissue elements of the graft fascicles, and one cannot exclude the possibility of some Schwann-cell proliferation in the sickle-shaped areas.

The terminal portion of the dissected mass of tissue consists of dense fibrous tissue in which there are no nerve-bundles and only a few aberrant nerve-fibres which have obviously grown in from neighbouring nerves.

**Case 3**—A soldier, H T, aged 24 years, was wounded in the right upper arm on May 29, 1940, and sustained a compound fracture of the lower end of the right humerus



**FIG 59**—*Case 3* Transverse section of central stump. There are several large bundles with a more or less normal proportion of myelinated and non myelinated fibres (Modified protargol method) ( $\times 15$ )

and a complete lesion of the radial nerve. The wound became heavily infected, and it was not possible to explore the nerve until Jan 20, 1941, 236 days after injury. After resection of the nerve-bulbs there was a gap of 6 cm between the proximal and distal nerve-trunks. Because of the ankylosed elbow-joint it was impossible to close this gap, even after extensive mobilization of the proximal and distal nerve-trunks. The gap was therefore bridged by a homograft taken from the radial nerve of a patient who had died 60 hours previously. The condition of the graft was not entirely satisfactory as the bundles were difficult to identify and the tissues of the graft were abnormally soft. The blood group of both donor and recipient was 'A'. There was some post-operative wound infection and the sinuses were not completely healed for two months.

There was no sensory or motor recovery and on July 13, 1943, 904 days after insertion, the graft was re-explored, under general anaesthesia, and a tendon transplantation performed. The proximal end of the nerve was found without difficulty, but at a point corresponding to the proximal suture line it disappeared into a mass of scar tissue, and it was impossible to identify any of the graft with certainty. The proximal end of the nerve, together with a strand of tissue, which was possibly the remains of the graft, was removed for histological examination.

#### HISTOLOGICAL EXAMINATION—

**Central End**—There are several large bundles with myelinated and non-myelinated fibres (*Fig 59*), some Schwann-cell proliferation, but no evidence of intra-fascicular fibrosis.

**Graft**—Nerve-fibres penetrate the graft for a distance of 15 mm. They are not, however, in well-defined fascicles, but run as small groups of aberrant fibres in the interfascicular tissue (Fig 60). Even had they grown into the peripheral stump it is doubtful if this small number of fibres would have had any functional value. There is no trace of the original nerve-bundles of the graft. The resected tissue consists of dense fibrous tissue and some skeletal muscle, there is no evidence of the original graft elements (Fig 61).

The following table gives the particulars of the remaining 5 cases. In each case the graft was taken from the corresponding nerve of a cadaver, as soon as possible after death. The number of hours that elapsed between the death of the donor and the insertion of the graft is given. In none of the patients was there any evidence of sensory or motor



FIG 60—Case 3. Small groups of aberrant fibres in scar tissue of proximal end of graft. (Modified protargol method) ( $\times 66$ )

recovery. In the patient J. H. this could be attributed to severe post-operative sepsis. The convalescence of the remaining 4 patients was uneventful. All the grafts, with the exception of the patient, J. P., were re-explored under local anaesthesia. No sensory or motor response was obtained on electrical stimulation of the grafts in any of the patients.

## DISCUSSION

The 8 cases of nerve homograft described here constitute a fair cross-section of the various types of injury to the large nerves of the limbs in which grafting may be indicated. They add to the already depressing list of homograft failures, testimony which ought to discourage the most sanguine from further

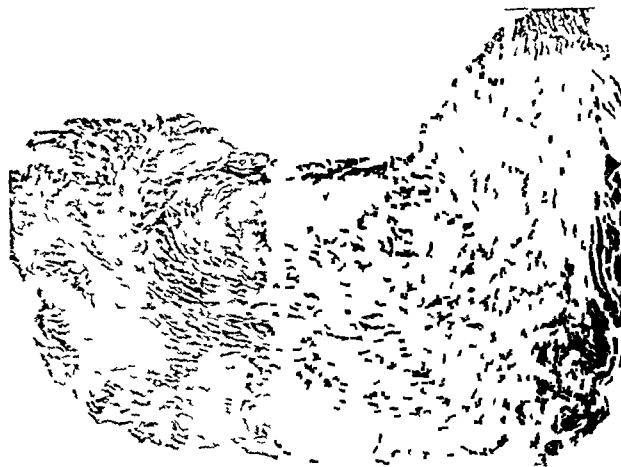


FIG 61—Case 3. Transverse section of the un-innervated part of graft. No trace of original fascicles. Section contains mostly dense, tendinous connective tissue (Haemalum and eosin) ( $\times 9$ )

clinical use at the present time. The use of the fresh homograft, the thermal and chemical treatment of stored homografts, modifications of operative technique such as plasma sutures, varieties of protective sleeve, and other expedients which have been tried from time to time—all these have proved of no avail. Loeb (1930) advanced a theory of 'organismal differentials' based on chemical characteristics to account for the fate of grafts, and more recently Gibson and Medawar (1943) and Medawar (1944) in their studies of skin-grafting have produced evidence that the reaction of the host to foreign tissue is the result of an "active acquired immunity".

Table I—DETAILS OF REMAINING 5 CASES OF NERVE HOMOGRAFTS

PATIENT	AGE	BLOOD GROUP	INJURED NERVE	INTERVAL IN DAYS BETWEEN WOUNDING AND GRAFTING OPERATION	LENGTH OF GRAFT	HOURS AFTER DEATH	BLOOD GROUP OF DONOR	DEGREE OF SCARRING OF GRAFT BED	DAYS BETWEEN INSERTION AND RE-EXPLORATION	STATE OF GRAFT	
										Identification	Adhesions
J. M.	55	AB	Radial	240	10 cm	—	—	++	385	Easily identified	++
J. H.	26	O	Sciatic	462	25 cm	8	A	+++	202	Graft could not be identified	—
J. P.	24	—	Posterior tibial	517	7 cm	30	—	None	—	—	—
W. B.	21	O	Median	526	10 cm	7	O	++	320	Easily identified. "Felt like a flexor tendon"	+
A. S.	28	O	Lateral popliteal	230	7 cm	12	A	None	732	Graft very difficult to identify. "Apparently converted to scar tissue"	— — —

Efforts to control this "active acquired immunity" can only be based on an understanding of the forces thus released against the donor tissue, which in turn demands a knowledge of the histopathological processes involved.

The main points of interest in the structure of the resected homografts are (1) The partial re-innervation of the grafts, (2) The fascicular necrosis, and (3) The fibrous replacement.

**Partial Re-innervation**—The most ready explanation of the penetration of regenerating axons into the proximal end of the grafts is a better vascularization of this region. It might be suggested that during the considerable interval of time from the initial injury to the graft operation, the progressive fibrosis of the isolated peripheral stump (Holmes and Young, 1942) will be accompanied by a decrease in its blood-supply and so the distal end of the graft is less efficiently vascularized. This argument, however, should apply with equal force to autografts, the majority of which are completely re-innervated (Seddon, Young, and Holmes, 1942; Barnes, Bacsich, and Wyburn, 1945), and animal homografts, where functional success occurs. In the case of the latter, it has been stated that the smaller size of the graft will facilitate vascularization. The important factor is, however, the size of graft relative to the size of the vascular pattern. Moreover, where there are adhesions, and this is especially so in the homograft, it is probable that many extra-neural vessels participate in the vascularization (Bacsich and Wyburn, 1945, a, b). In the three cases examined there was no evidence of any marked variation in the number of blood-vessels throughout the length of the graft. Spurling et al (1945) also found it impossible to correlate the growth of axons into nerve homografts with the degree of vascularity. We agree with Seddon and Holmes (1944) that inadequate vascularization is not a satisfactory explanation of the partial re-innervation of homografts and accept their tentative suggestion that the length of graft traversed by axons is an index of the latent period during which the host acquires the active immunity.

How does the presence of host nerve-fibres affect the fate of the graft? There are two possibilities. Sanders and Young (1942) believe that in the re-innervated homografts of rabbits much of the graft tissue survives. For example, they state that the original architecture is preserved, that there is proliferation of graft Schwann cells, and the invading axons occupy the endoneurial tubes of the graft. There is no question of these animals (rabbits) possessing a tolerance to foreign tissue. Therefore it must be assumed that the new fibres in some way insulate and protect the graft against the hostilities of the host tissues and that in successful animal homografts the axons are able to traverse the entire length of the short grafts before active immunity is acquired and are thus able to protect it.

On the other hand, Bentley and Hill (1936) state that in the cat, where homografts, provided they are not too large, are successfully innervated, the graft tissue is totally destroyed. They contend that the new fibres provide their own sheaths from host Schwann cells and that the presence of host nerve-fibres does not affect the final fate of the nerve-graft,

which, like the skin homograft, is ultimately completely replaced by host tissue. They therefore believe, and we are inclined to agree with them, that the function of the graft is to provide a necessary but temporary scaffolding for the new fibres. Success will depend on the nerve-fibres reaching the peripheral stump while the graft is still in a condition to act as a scaffold.

**Fascicular Necrosis**—Whatever the nature of the forces mobilized against the graft in the first instance, the result is a necrosis of the fascicular contents and their subsequent replacement by fibrous tissue. There are scant records of the early changes in nerve homografts. Bentley and Hill (1936) described in the cat a heavy leucocytic infiltration of a nerve homograft at 60 days, while Sanders and Young (1942) noticed a considerable lymphocytic invasion of some of their rabbit nerve homografts after 25 days. Eden (1919), who transplanted a piece of human nerve into the subcutaneous tissues of another patient for 38 days, found, not Wallerian degeneration, but a slow necrosis of the nervous elements and their replacement partly by cells from the surviving graft and partly by proliferated host connective tissue. He, however, makes no comment on how the necrotic material is removed. In our series of homografts there was no evidence of macrophages or endothelial proliferation such as is found during repair of injured nerve in rabbits (Bacsich and Wyburn, 1945). Perhaps, considering the age of the graft, this is not surprising, but there remains the question of the method by which the necrotic material is removed.

It seems probable, although conjectural, that the nerve homograft, like the skin homograft (Medawar, 1944) at an early stage evokes something of the nature of an inflammatory reaction which later subsides. In the youngest homograft (140 days) the un-innervated fascicles are filled with necrotic tissue, except for a zone of sickle-shaped cellular fibrosis invariably found on the outer segments. In the oldest homograft (904 days) all that remains of the un-innervated portion is strands of scar tissue in the midst of muscle fibres. In the un-innervated portion of the homograft in *Case 1* (355 days) there are fascicles completely filled with necrotic tissue, and others with an area of central necrosis enclosed by a zone of fibrosis. In this graft it is possible to see in the same section fascicles wholly occupied by fibrous tissue, which may be cellular or may be densely collagenized and with difficulty distinguished from the interfascicular tissue. The stage of fascicular necrosis appears to be gradually succeeded by a fascicular fibrosis until finally the original architecture is lost and the graft is represented merely by a homogeneous mass of dense connective tissue. We can find no reasonable explanation to account for the different conditions of the fascicles in *Case 1*. There is no relationship between the position of the graft fascicles in either longitudinal or transverse sections and their progress towards final obliteration.

**Fibrous Replacement**—In the three grafts examined the rather loose connective tissue with a fair amount of fatty tissue which forms the interfascicular substance of a normal nerve is replaced by a dense fibrous tissue of the consistency of tendon.

It cannot be stated with certainty that there is no survival of the original graft tissue, but there is little doubt that the host fibroblasts invade and may possibly completely replace the original interfascicular tissue. That this may be so is supported by the observation that the older the graft the more difficult it becomes to distinguish it from surrounding tissues until finally the only clue to its identity is the knowledge of its former position, e.g. *Case 3*, where even on microscopical examination there is no evidence of the original graft (the initial unsatisfactory condition of the graft, and the subsequent sepsis would probably influence the final condition in this instance). In *Case 2* the sickle-shaped fibrous areas involving the outer segments of the ring of necrotic fascicles might well represent an invasion of the surrounding host tissue towards the centre of the graft. As has already been noted, however, there is an abrupt transition from the dense interfascicular to the cellular intrafascicular fibrous tissue and the two areas remain separated by a well-preserved perineurium. In *Case 1*, there are a number of fascicles in part occupied by dense fibrous tissue directly continuous with the surrounding interfascicular tissue without any intervening perineurium, and others which have become totally collagenized and merged into the general fibrous tissue background. While, therefore, there is at one stage proliferation of the connective-tissue cells of the graft (sickle-shaped areas of cellular connective tissue), the microscopical picture of the late condition of the homograft is more suggestive of the total replacement of the necrotic fascicles by the tissues of the host.

The fate of a nerve homograft is fundamentally different from that of an autograft or an isolated peripheral stump (in many ways comparable to an un-innervated autograft), where the architectural characteristics are preserved and fibrosis is the result of the proliferation of their own connective-tissue elements. Moreover, in the case of the isolated peripheral stump, subsequent, although imperfect, innervation is possible (Holmes and Young, 1942; Barnes, Bacsich, and Wyburn, 1945).

Spurling et al (1945) imply that the main deterrent to the further penetration of the nerve-fibres into the homograft is inter- and intrafascicular fibrosis. It seems, however, unlikely that there is further growth of axons after the host has acquired immunity, and if our interpretation of the subsequent sequence of events within the graft is correct, fascicular necrosis precedes the invasion and replacement by fibrous tissue which is a late condition and has not yet occurred in many of the un-innervated fascicles even after 355 days.

In the majority of cases there was severe scarring of the graft bed. Spurling et al (1945) suggest that this may interfere with vascularization of the graft. It cannot, however, be a deciding factor, for in our two traction injuries of the external popliteal nerve there was virtually no scarring of the graft bed, and, furthermore, soft-tissue scarring did not prevent neurotization of the autografts reported by Seddon, Young, and Holmes (1942), and Barnes, Bacsich, and Wyburn (1945).

The blood group of donor and recipient were known in 5 cases, and in 2 of those the blood groups

of donor and recipient were identical. The consensus of present opinion (Seddon and Holmes, 1944; Spurling et al, 1945; Medawar, 1944) regards blood compatibility of the recipient and donor as irrelevant to the problem of the homograft. The test of blood compatibility has been confined to the normal grouping. A more intimate serological analysis might produce a different result, but might equally well so limit the possible source of the homograft as to render the procedure in large measure impracticable.

Unless some method is devised of prolonging the presence of the homograft as a scaffolding for the regenerating nerve-fibres until the nerve gap is bridged, then there is no justification for the use of homografts for the repair of large gaps in peripheral nerves in man.

### SUMMARY

Eight human nerve homografts are reported, all of them failures. With one exception the grafts were removed and examined histologically at times varying from 140 to 904 days after their insertion. In 3 cases the histological findings are given in detail.

We agree with Seddon and Holmes (1944) that inadequate vascularization is not a satisfactory explanation of the partial re-innervation of homografts, and accept their tentative suggestion that the length of graft traversed by axons is an index of the latent period during which the host acquires the active immunity to the homograft.

The fascicles of the un-innervated part of the graft undergo necrosis and are finally completely occupied by fibrous tissue, at first cellular, later collagenous.

The histological picture, after a period of 904 days, suggests that ultimately there is total replacement of graft by the tissues of the host.

The opinion is expressed that the function of the graft is to act as a temporary scaffolding for the regenerating nerve-fibres.

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# ANALYSIS OF A SERIES OF 454 INGUINAL HERNIÆ WITH SPECIAL REFERENCE TO MORBIDITY AND RECURRENCE AFTER THE WHOLE SKIN-GRAFT METHOD

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A PRELIMINARY report on the use of whole skin-grafts for the repair of hernia has been published (Mair, 1945, a, b), but without reference to results. This paper deals with an analysis of a series of 454 inguinal herniæ operated upon by myself, of which 149 were repaired by the whole-skin method.

The purpose of this contribution is to discuss the results so far achieved by this method and to compare morbidity and recurrence against figures for other operations, both in this series and from other clinics.

No comparative statistics for the skin method of repair are available.

In assessing morbidity and recurrence figures, the conclusions reached are, with the exception of 43 cases, those of myself and a colleague. In the 43 exceptions the patients were soldiers. They were sent a questionnaire which was completed by the battalion Medical Officer.

For the purpose of this investigation an attempt was made to trace every patient for a minimum of one year after operation. In some cases the period is well over two years. It is of interest that of 21 recurrences, all save one developed within the first year, and most within nine months.

**Number of Cases in the Series**—The total number of patients investigated was 402, but of these 52 had bilateral herniæ, making a total of 454 operations.

**Proportion of Direct to Indirect**—Of the 454 herniæ, 104 were direct, that is, 22.9 per cent. Twelve of these were "saddle-bags", that is, there was an associated indirect sac on the same side.

**Association with Strain**—No history of abnormal strain relating to the onset of the condition was given in 319 cases. In 5.2 per cent there was definite history of severe, and in 24.4 per cent there was a history of moderate strain, which, in the opinion of the patient, contributed to the onset of the condition.

**Association with other Herniæ**—Twelve direct cases had an associated indirect sac upon the same side. In 52 cases there were bilateral herniæ. Four had a femoral hernia upon the contralateral side, 2 an epigastric hernia causing symptoms, and 1 a large umbilical hernia.

**Death-rate**—One patient died on the eighth post-operative day. The cause of death was obscure, and not satisfactorily revealed by autopsy. Signs of internal hæmorrhage developed on the fifth post-operative day and the patient died three days later. At autopsy there was found an acute yellow atrophy of the liver and an intraperitoneal hæmorrhage, the source of which was not located, but was considered possibly to have sprung from an aneurysm of the splenic artery.

The operation was for a plastic repair of a large direct hernia using a whole skin-graft. No technical difficulties were encountered at operation, and the death proved an unexpected and unaccountable surprise.

**Strangulation**—There were 10 cases of strangulation (2.2 per cent). In 4 of these the small intestine was involved, and in 6 only the omentum. Resection of gut was necessary in 3 of the 4 cases involving bowel. In the omentoceles the strangulated omentum was excised. There were no deaths. No attempt was made in any case to do more than deal with the strangulation and attempt to save life.

**Incarceration**—Nine cases were incarcerated (1.9 per cent). At operation the constriction was freed and a suitable repair performed.

**Reducibility**—The remainder of the series were reducible (95.9 per cent).

**Associated Lesions**—Hydrocele was present in 3.5 per cent of cases, varicocele in 3 per cent, undescended testicle in 2.2 per cent, and chronic bronchitis in 8.8 per cent. Other conditions—for example, duodenal ulcer, cholecystitis—which have no direct bearing upon the aetiology, progress, treatment, or complications of inguinal herniæ are not included.

**Special Types of Herniæ**—There was one true example of a hernia *en bis sac*, and seven of hernia *en glissade* where the cæcum alone was involved. They were all on the right side. In five of the direct cases the bladder was extrasacculal and related to the hernia, but caused no especial difficulty at operation.

There were 2 cases of cruroscrotal hernia. In these the spermatic cord traversed the femoral canal to enter the scrotum. The herniæ were both inguinal.

No examples of interstitial or properitoneal sacs were encountered.

**Operations Performed**—All patients were treated by one of four operations: a classical Bassini, simple

Table 1—NUMBER OF OPERATIONS PERFORMED

	INDIRECT HERNIA	DIRECT HERNIA	TOTAL
Bassini	67	21	88
Herniotomy	90	4	94
Fascia	80	43	123
Skin graft	113	36	149
Total cases	350	104	454

herniotomy with suture of the fascia transversalis and narrowing of the pillars of the internal abdominal muscular ring, a Gallie fascial hernioplasty,

or by a whole skin-graft inlay. The technique of the whole skin-graft method has been described elsewhere (Mair, 1945, a, b).

In the following and other tables the first figure gives the percentage, whilst the second pair of figures indicates the number of complications out of the total number of cases considered, e.g., wound sepsis for the Bassini operation is 5.5 per cent, that is 5 cases of sepsis out of 88 operations (5/88).

### EARLY POST-OPERATIVE COMPLICATIONS

Table II—EARLY POST-OPERATIVE COMPLICATIONS

COMPLICATIONS	BASSINI	HERNIOTOMY	FASCIA	SKIN
Wound sepsis	5.5 (per cent) 5/88	3.1 (per cent) 3/94	4.8 (per cent) 6/123	3.3 (per cent) 5/149
Hæmatoma wound	1.1 (per cent) 1/88	5.3 (per cent) 5/94	2.4 (per cent) 3/123	3.3 (per cent) 5/149
Hæmatoma scrotum	3.3 (per cent) 3/88	1.0 (per cent) 1/94	2.4 (per cent) 3/123	3.3 (per cent) 5/149
Orchitis	0	0	0	0.6 (per cent) 1/149
Post-operative chest complications	10.2 (per cent) 9/88	22.3 (per cent) 21/94	13.0 (per cent) 16/123	12.0 (per cent) 18/149

Comparison of these post-operative conditions (Table II) demonstrates that herniotomy in my experience carries with it the highest incidence of chest complications. The explanation for this is obscure, but those patients who most frequently developed chest complications were young and active soldiers, accustomed to a healthy outdoor life.

**Wound Sepsis**—The highest incidence of wound sepsis was after the classical Bassini operation. I do not consider this to be other than a coincidence, and to be an observation of little practical value.

In regard to fascia and skin, the higher incidence of local wound sepsis follows the use of fascia, the difference is approximately 1.5 per cent, fascia having 4.8 per cent sepsis and skin 3.3 per cent. These cases generally cleared up rapidly. One of the skin cases persisted for four months, but upon re-examination one year after the wound had finally healed there was no sign of recurrence. It is only fair to add that the degree of sepsis was slight, and that after the third week only a faint stain was present on the 24-hour dressing.

Sepsis has given no trouble of consequence in the skin cases, but it has been found that the skin-graft operation may be associated with a curious phase during the early post-operative period.

During the end of the first week, and sometimes lasting well into the third, the wound may be slightly indurated and occasionally a little inflamed. In no case has this gone on to pus formation, nor has it been associated with pyrexia, pain, or constitutional

upset. It is most probably due to local activity around the graft during the period of phagocytosis of the epidermis and infiltration of the graft with granulation tissue. The appearances suggest a very low-grade deep sepsis, and are not constant. It has been observed in approximately 25 per cent of my total series. By the end of three weeks from the date of operation the wound is entirely normal, the slight superficial redness has disappeared, and the induration generally gone. Occasionally there may be some very slight deep induration for a further week or ten days.

It is important to recognize this happening and also to note that in my experience it has been of no serious significance, there has been neither subjective local upset or constitutional disturbance. The end results were satisfactory.

*It is important that at the original operation the skin preparation technique described elsewhere be adhered to (Mair, 1945, a, b).*

**Hæmatoma of Wound**—Every effusion of blood in relation to the wound has here been considered. There has been no example of a hæmatoma which required to be opened or which discharged more than a few drops of blood-stained fluid from a superficial bleb on the scar sometime during the early second week.

Herniotomy has been associated with the highest incidence of this complication. It is my opinion that this is largely due to straining by coughing during the early post-operative period, as it has been observed that these young men may be more restless coming out of the anæsthetic than sedentary workers, and older persons.

**Hæmatoma of Scrotum**—As might be expected hæmatoma of the scrotum is not common after simple herniotomy, and only one case was encountered.

The skin-graft operation and the classical Bassini have the same incidence of this complication, 3.3 per cent. I incline to the belief that this is partly due to the sutures inserted immediately lateral to the pubis in these operations, and in the case of the skin repair, to one other factor. The external oblique is detached for about 1 in from its pubic attachment in order the better to expose the pubis and lower rectus sheath. This step is sometimes associated with oozing from vessels between that muscle and the rectus. This can migrate into the scrotum to cause hæmatoma. There was no case of a large hæmatoma and seldom was there more than some scrotal discoloration with slight swelling above the testis and in the line of the cord. The condition is more frequent when the testis has to be delivered into the wound.

**Orchitis**—This complication was observed only once, and that in relation to a skin-graft repair. No explanation for it is forthcoming. The condition was not acute and subsided within a week of onset.

### COMPARISON OF PERSONAL FIGURES WITH THOSE OF OTHER CLINICS

**Sepsis**—O'Shea (1935) found an incidence of 3.8 per cent sepsis in uncomplicated cases taken as a whole and without regard to type of operation. In relation to fascia, Erdman (1923) had 4.8 per cent

sepsis, Lyle (1928) 1 per cent, and Fallis (1940) also 1 per cent. In some hands the figure is higher. My own figure for the fascial operation is 4.8 per cent.

The skin-graft repair has a 3.3 per cent incidence of sepsis after 149 operations. This compares quite favourably with the average figures for sepsis in relation to fascia, and is a little better than that quoted by O'Shea.

**Post-operative Chest Complications**—Lucas (1937) gave carefully detailed figures for post-operative chest complications in relation to hernia operations and for different types of anæsthetic media. He classified his complications into severe, moderate, and slight. Discarding the slight cases and considering only the severe and moderate and after nitrous oxide, oxygen, and ether anæsthesia, he had, for 85 cases a total incidence of 30.6 per cent chest complications.

This is higher than in my own experience for any type of hernia operation, my highest figure being for herniotomy with 22.3 per cent chest trouble. Lucas is an anæsthetist. Other figures are available from surgeons.

Davis (1916) has analysed 1500 cases and found the incidence of 9.2 per cent post-operative bronchitis after the Bassini operation, on the other hand, Gibson and Felter (1930) had but 1.7 per cent. For the Bassini operation I found 10.2 per cent post-operative bronchitis in a series of 88 cases.

The figures published range from the low level of Gibson and Felter to the high levels of Lucas.

In regard to the skin operation I had 12 per cent as against 13 per cent with fascia.

**Scrotal Hæmatoma**—Gibson and Felter (1930) found 3.1 per cent scrotal hæmatoma after the Bassini operation. This is almost the same as my own experience for the Bassini and skin operations, 3.3 per cent and 3.3 per cent respectively.

Erdman (1923) in relation to fascia had 9 per cent scrotal hæmatoma. This is higher than my own figures for fascia (2.4 per cent) and also for skin (3.3 per cent).

Davis (1916) found 7 per cent hæmatoma after the Bassini operation, a figure higher than those of Gibson and Felter (1930) or myself, whilst Fallis (1940) had but 0.8 per cent in his series.

**Summary**—The figures of my series compare quite favourably with those considered from other sources, and the skin-graft operation is not associated with any high incidence of early post-operative complications of significance. In my hands the early post-operative complications for fascia and skin-grafts run closely together, and with no significant difference between.

It is necessary to compare the late results of the various operations which were followed up, and to endeavour to assess the evidence in relation to the efficiency or otherwise of the skin type of repair.

## LATE RESULTS OF OPERATIONS FOR INGUINAL HERNIA

It was not possible to follow up all the cases, though a considerable effort was made to do so.

With few exceptions the results are determined by examination one year or over from the date of the original operation. In some cases an opportunity

arose to see the patients within a year. *Table III* shows the interval after treatment before re-examination in relation to each of the four operations under consideration.

*Table III*—INTERVAL AFTER OPERATION BEFORE RE-EXAMINATION

DURATION IN MONTHS	6-9	9-12	12-15	15-18	18-24	24-30	30-36
Bassini	0	0	4	11	9	4	0
Herniotomy	4	7	15	4	3	3	0
Fascia	0	0	30	15	30	10	1
Skin	3	9	66	9	0	0	0

Thus, of the 454 operations performed 237 were followed up, and of these, 212 were observed after one year.

Each patient was re-examined by two people. There were 43 cases in soldiers where it was not possible to re-examine them personally. These were sent a questionnaire which was filled in by their Army Medical Officer.

*Table IV*—LATE POST-OPERATIVE COMPLICATIONS

COMPLICATIONS	BASSINI	HERNIOTOMY	FASCIA	SKIN
Pain in the wound	14.2 (per cent) 4/28	0 (per cent)	5.8 (per cent) 5/86	1.1 (per cent) 1/87
Hydrocele	0	0	0	1.1 (per cent) 1/87
Varicocele	0	0	0	0
Atrophy of testis	0	2.7 (per cent) 1/36	0	0
Fatigue	11.5 (per cent) 3/26	0	2.3 (per cent) 2/86	0
Thickening of epididymis, or chronic orchitis	7.6 (per cent) 2/26	5.5 (per cent) 2/36	1.1 (per cent) 1/86	1.1 (per cent) 1/87

In the cases of the Bassini and the group of herniotomies, the numbers traced are not large (*see Table III*), but suitable comparisons may legitimately be made between the fascia and skin repairs.

**Pain in the Wound**—This is more common after fascia than with skin, 5.8 per cent as against 1.1 per cent.

I have been unable to trace observations based upon statistical evidence for this late complication in the literature, but feel that in the case of the series of skin-graft cases the numbers are not high enough to be an adverse criticism of the operation.

It is not easy to assess precisely any subjective symptom such as wound pain. One can be guided only by the patients' expressions of opinion. I have included each who complained of any wound



pain at all. Certain people have stated that they occasionally were aware of a 'funny feeling' in the operation area. This seems to be interpreted as meaning 'an awareness of the scar' and generally observed after exercise or when sweating. It has been included as 'pain'. It was not met with often.

Pain in the thigh wound is a complication peculiar to fascial operations. Again it is a subjective symptom. I found no instance where pain was complained of at the time of re-examination, but a number of patients stated that they had experienced pain in the thigh wound after leaving hospital. This persisted for only a few weeks in the average case, though for two months in one patient. Usually it was not severe, and in no instance did it compel him to refer to his doctor.

**Hydrocele**—This complication has been indicated in the literature as occurring as often as in 13.4 per cent of cases after the Bassini operation (Bloodgood). Gibson and Felter observed it after 4 per cent of their Bassini cases (1930), and Patterson (1928) in 3.5 per cent after fascial repairs.

Only one case was found in my total series, and that followed a skin repair. The hydrocele was small and symptomless.

**Varicocele**—No cases of varicocele were found.

In my view the absence of varicoceles and the presence of only one hydrocele is important in relation to the skin repair. It has been suggested by colleagues that the skin may be stitched so tightly around the internal ring as to compress the cord and give rise to one or other of these complications. Theoretically this is so, and yet, though the skin has in each case been disposed so as to protect effectively the internal ring, there have been no signs that the procedure is fraught with danger.

**Atrophy of Testis**—This complication also might be expected if the cord were too tightly compressed. It was found only once, and that following upon a herniotomy. The operation was complicated by a scrotal hæmatoma which later was followed by atrophy. The hæmatoma was not so large as might have been expected in view of the sequel, but was approximately the size of a duck egg.

**Fatigue**—This symptom may be complained of for long after any operation, and it is curious that it is more common in my series after Bassini repairs than by other methods. There is no reason why the Bassini operation should be more than usually prone to this complication.

**Chronic Epididymo-orchitis**—This term is used here to embrace thickening of the cord in the upper scrotum, epididymitis, orchitis, and epididymo-orchitis.

Erdman found 15 per cent of Bassini cases showing late thickening of the cord in the upper part of the scrotum. It is not a condition which is commonly discussed in the literature, and I could find no other quoted figures for the lesion.

In my own series it was most common after the Bassini, and secondly, after herniotomy, 7.6 per cent and 5.5 per cent respectively. The fascial and skin repairs were equal with 1.1 per cent each.

**Summary**—In the analysis of the followed up cases for late complications, the results for the skin repair compare satisfactorily with those for other

operations, and with those of other surgeons. There is no evidence to suggest that the operation is associated with any danger of late difficulties referable to the implantation of the skin.

It is, in fact, surprising how completely free from deep thickening the operation area is. The scar is usually satisfactory.

I can report that the late results of these skin repairs have been satisfactory so far as morbidity is concerned.

The data peculiar to both types of inguinal hernia, and especially in regard to recurrence figures, must now be considered.

## INDIRECT INGUINAL HERNIA

**Sex Incidence**—There were 350 indirect herniæ, of which 4 per cent (14) were females.

**Situation**—Of these, 212 (60.5 per cent) were on the right side, 138 on the left.

**Type of Operation**—The cases were dealt with according to Table V.

Table V—TYPES OF OPERATION

Type of Operation	No. of Cases
Bassini	67
Herniotomy	90
Fascia	80
Skin	113

Approximately three-fourths of the cases required some form of repair.

**Recurrence Rate**—Every case which presented a bulge over the operation area was considered to be a recurrence. If there were any doubts as to cure it was listed as failure.

**The Bassini Operation**—Of the 67 Bassini operations performed for indirect inguinal hernia it was possible to trace only 22, and of these there were two recurrences (9 per cent). The numbers traced are not sufficiently large to be of value.

Of the two recurrences, one was examined thirteen months after operation and the other twenty-four. The first recurred after five months and the second after three.

**Simple Herniotomy combined with Suture of the Fascia Transversalis**—This conservative operation was performed in 90 cases, and the late result traced in 32. There were 2 recurrences (6.2 per cent). Of these, one recurred at the end of the first post-operative month, the second patient was uncertain as to how long after operation before the swelling reappeared.

**Fascial Repair by the Gallie Method**—This method was used in 80 cases and the results traced in 59. There were two recurrences, (3.3 per cent), one after eight months and the other after four.

**Whole Skin-graft Repair**—The operation was performed 113 times and the results traced in 86. There was one recurrence (1.1 per cent). This followed six months after operation and two months after return to work. The skin repair was performed on a recurrent hernia originally repaired by fascia in a man aged 54. The hernia recurred ten months after the original operation and a skin repair was performed for the recurrence.

The graft was anchored with linen sutures. At the operation for recurrence each linen stitch was surrounded by a minute focus of infection in which



there was a pool of pus. From the pus no organisms were cultured. The graft had failed to attach itself at the medial end and the recurrence was in the form of a large direct hernia.

These results are considered in *Table VI*.

*Table VI*—RECURRENT RATES AFTER OPERATIONS FOR INDIRECT INGUINAL HERNIA

TYPE OF OPERATION	NUMBER PERFORMED	NUMBER TRACED	PERCENTAGE RECURRENT
Classical Bassini	67	22	9.0
Herniotomy	90	32	6.2
Fascial repair	80	59	3.3
Whole skin graft	113	86	1.1

### DIRECT INGUINAL HERNIÆ

A total number of 104 operations were performed for direct inguinal hernia.

*Sex Incidence*—98 were in males. All were in adults.

*Situation*—54 were on the right side.

*Type of Operation*—The cases were dealt with according to *Table VII*.

*Table VII*—DIRECT INGUINAL HERNIA TYPE OF OPERATION

Type of Operation	No. of Cases
Bassini	21
Herniotomy	4
Fascia	43
Whole Skin	36

In the cases which were dealt with by herniotomy the sac was funicular, and after its removal the rent in the fascia transversalis was sutured by a continuous stitch of chromicized catgut.

*Type of Direct Hernia*—Of the total number of direct herniæ 32 were diffuse and 57 funicular. The remainder were either recurrent or associated with an indirect sac.

*Results of Operation (Table VIII)*—

*The Bassini Operation*—Twenty-one patients were treated by this method and of these only 4 were traced. There were three recurrences (75 per cent). These developed ten, three, and eight months respectively after operation. I have seen no worse recurrence rate than this reported anywhere for direct hernia. One can only comment that the number is too small to be significant.

*Simple Herniotomy*—This was performed for the funicular type of direct hernia in 4 cases, all of which were traced. Recurrence had followed in 3 (75 per cent). These recurred four, five, and four months after operation respectively.

*Fascial Repair by the Galhe Method*—There were 43 operations of this type and of these 27 were followed up for re-examination. There were 8 recurrences. All were examined after an interval of at least one year, and they recurred after six, three, fourteen, six, three, and six months respectively. In 2 cases the patients were uncertain as to how long after operation before the swelling reappeared. The recurrence rate is 29 per cent.

*Skin-graft Repair*—This technique was used in 36 cases and the late results traced in 27. There

was no true recurrence, but one patient developed a femoral hernia on the same side as the skin operation. This patient had a long and complicated history of hernia. He was operated on originally for an indirect hernia and a Bassini repair performed. A recurrence developed and I did a fascial repair. This recurred, and the third operation was for a direct recurrent hernia. The skin technique was used. On examination ten months after operation, he was found to have a small but very typical femoral hernia. The posterior wall of the inguinal canal was perfectly firm and sound. I do not regard this as a recurrence. It should be mentioned that the patient has a direct inguinal hernia on the other side and is a chronic bronchitic. He is asthenic in type and a poor operative subject.

*Table VIII*—RESULTS OF OPERATION FOR DIRECT INGUINAL HERNIA

TYPE OF OPERATION	NUMBER PERFORMED	NUMBER TRACED	PERCENTAGE RECURRENT
Classical Bassini	21	4	75
Herniotomy	4	4	75
Fascial graft	43	27	29
Skin-graft	36	27	0 One femoral hernia later developed

### COMPARISON OF RESULTS WITH THOSE OF OTHER CLINICS

The following tables give results of operations reported by other clinics.

*Table IX*—RECURRENT FIGURES FOR INDIRECT INGUINAL HERNIÆ TREATED BY A BASSINI OPERATION

SURGEON	OPERATION	NUMBER	PERCENTAGE RECURRENT
Fallis (1940)	Halsted	1386	8.6
Fallis (1940)	Bassini	214	13.4
Oedenarde (1922)	Bassini	French Navy	10.0
Goldner	Bassini	466	8.0
Coley (1924)	Classical Bassini	332	8.7
Andrews (1924) Massachusetts General Hospital	Bassini	—	9.0
Druner (1920)	Bassini	—	21.4
Andrews (1924), Bellevue, N.Y.	Bassini	—	7.5
Andrews (1924), Johns Hopkins Hospital, Boston	Bassini	—	10.9
Max Page (1943)	Bassini	London Police	20.2
Selinger (1927)	Classical Bassini	266	18.0
Erdman (1923)	Bassini	1093	6.67
Taylor (1920)	Bassini	816	5.6
Schwartz (1922)	Bassini	207	6.0
Average recurrence			11.8

Table X—RECURRENCE RATE FOR INDIRECT INGUINAL HERNIÆ REPAIRED BY FASCIAL SUTURES

SURGEON OR CLINIC	OPERATION	NUMBER	PERCENTAGE RECURRENCE	FOLLOW-UP
Grey (1940), Stobhill, Glasgow	McArthur	54	7.4	3 yr
Foster (1936)	Gallie	101	7.0	1.5 yr
Lyle (1928)	McArthur	100	3.0	1 yr
Cattell-Anderson, McLoskey, and Lehman (1940)	McArthur	123	4.6	1 yr
Andrews (1928)	McArthur	43	9.3	1 yr
Gould (1940)	Gallie	87	9.2	1 yr
Average recurrence rate for indirect herniæ			6.75	

Table XI—RECURRENCE STATISTICS FOR DIRECT INGUINAL HERNIÆ TREATED BY THE BASSINI OPERATION

CLINIC OR AUTHOR	NUMBER OF CASES	PERCENTAGE RECURRENCE
Erdman (1923)	—	16.1
Andrews (1924), Massachussets General Hospital	—	15.0
Andrews (1924), Johns Hopkins Hospital	—	29.1
Taylor (1920)	77	22.0
Watson (1924)	—	20.0
Falhs (1940)	154	11.6
Coley (1924)	280	5.0
Max Page (1943)	London Police	25.8
Gibson and Felter (1930)	427	6.5
Average recurrence		16.8

Table XII—RECURRENCE RATE FOR DIRECT INGUINAL HERNIÆ REPAIRED BY FASCIAL SUTURES

SURGEON	OPERATION	NUMBER	PERCENTAGE RECURRENCE
Robins, McLoskey, and Lehman (1940)	McArthur	27	0
Lyle (1928)	McArthur	54	9.5
Cattell-Anderson, McLoskey, Lehman (1940)	McArthur	51	7.8
Cattell-Anderson, McLoskey,	Gallie	—	11.7
Average recurrence rate for direct herniæ			5.6

**Indirect Inguinal Herniæ**—Analysis and comparison of the figures on *Tables VI, IX, and X* show that my figures for the Bassini operation and for fascia correspond closely with those of the average worker.

In the case of the skin-graft series (*Table VI*) the results are satisfactory. It can be claimed that there has not been a failure after primary operation, the only recurrence taking place after previous fascial hernioplasty.

**Direct Inguinal Hernia**—The numbers of cases traced are small so far as any series of

operations is concerned, but in the few cases of Bassini and herniotomies they are so small as to be of little value. The results are bad. Even with fascia the results are poor and compare badly with those reported on *Tables XI and XII*, but there is dramatic improvement with the whole-skin technique, the results of which exceed any claims I have observed in the literature for this condition.

**Selection of Cases**—There has been no selection of cases, and the series reported is consecutive, embracing all direct herniæ with which I have had to deal during the year, October, 1943, to October, 1944.

A total of 237 operative late results were traced, with 21 (8.8 per cent) recurrences (*Table XIII*).

Table XIII—ANALYSIS OF RECURRENT CASES

TYPE OF HERNIA	INTERVAL BEFORE RECURRENCE	TYPE OF ORIGINAL OPERATION	TYPE OF RECURRENCE	AGE
Months				
Left indirect	4	Fascia	Direct	40
Right indirect	4	Herniotomy	Direct	18
Saddle bag	5	Bassini	Direct	58
Saddle bag	6	Skin	Direct	53
Left Direct	8	Bassini	Direct	39
Right indirect	?	Herniotomy	Indirect	40
Left direct	6	Fascia	Direct	27
Right indirect	5	Herniotomy	Direct	19
Left indirect	3	Bassini	Indirect	30
Right indirect	4	Herniotomy	Direct	19
Left indirect	3	Fascia	Direct	25
Right indirect	14	Fascia	Direct	61
Left direct	6	Fascia	Direct	32
Right direct	?	Herniotomy	Indirect	23
Left direct	3	Bassini	Direct	54
Left indirect	8	Fascia	Indirect	64
Right indirect	3	Fascia	Direct	54
Right indirect	3	Fascia	Direct	41
Left indirect	6	Fascia	Direct	49
Right direct	?	Fascia	Direct	51
Right indirect	10	Bassini	Direct	44

**Duration before Recurrence**—With one exception, all recurred under one year of operation, and of the 21 recurrences 13 did so before the seventh month. In 4 instances the patient was uncertain as to the time interval before the reappearance of the swelling. Thus, 13 out of 17 cases developed in the first post-operative six months.

**Type of Recurrence**—Four cases only recurred as indirect herniæ, and in one of these the original operation was for a direct.

## CONCLUSIONS

From an analysis of a series of cases of direct and indirect inguinal herniæ treated by myself, the evidence is overwhelming in suggesting that best results are achieved, in those cases which require more than simple herniotomy, by the use of the whole-thickness skin-graft technique.

The results of the skin-graft operation in the analysed series compare very favourably with any other results published for other types of operation from other clinics.

The early and late morbidity also compare favourably with the experiences of other clinics for other types of repair.

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## A CASE OF ALBRIGHT'S SYNDROME (OSTEITIS FIBROSA DISSEMINATA)

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FOR a number of years it has been recognized that generalized osteitis fibrosa (von Recklinghausen's disease) is caused by excessive secretion of parathyroid hormone, usually associated with adenoma of the parathyroid glands. Patients suffering from the malady exhibit widespread decalcification of the skeleton with foci of osteitis fibrosa, high values for serum-calcium and plasma-phosphatase, and low values for plasma inorganic phosphorus. Excessive amounts of calcium are excreted by the kidneys. Cases of fibrous dysplasia of bone occur, however, which, while resembling generalized osteitis fibrosa, differ from that disease in regard to the extent and distribution of the skeletal changes, in blood-chemistry, and usually in the absence of increased excretion of calcium by the kidneys. In several cases of this type explored for parathyroid adenoma, no tumour has been found. In 1937, Albright et al described a group of such cases (4 females and 1 male) presenting certain clinical, radiological, and pathological features in common, which seemed to constitute a definite syndrome. The authors described the syndrome as characterized by —

"a Bone lesions which have a marked tendency to be unilateral and which show osteitis fibrosa on histologic examination

"b Brown, non-elevated, pigmented areas of skin which tend to be on the same side as the bone lesions

"c An endocrine dysfunction which in females is associated with precocious puberty"

In this group of cases the disease commenced in the early years of life. The generalized porosity of the bones of parathyroid adenoma was lacking, the bone lesions being spotty in distribution, with normal bones in between. Serum-calcium and plasma inorganic phosphorus values were within normal limits, and urinary calcium excretion was not elevated. Blood-phosphatase was elevated in cases with advanced bone lesions. In the female patients, the disease was attended by both precocious puberty and precocious bone-age, with early union of epiphyses. In the one male subject there was slight precocity of bone development, but no sexual precocity.

In the following year, Albright, Scoville, and Sulkowitch (1938) recorded 2 more cases of the syndrome occurring in male subjects. In one case, aged 21 years, with severe bone lesions, there was increased urinary excretion of calcium, although the values for blood-calcium and blood-phosphorus were within the normal range. The blood-phosphatase was elevated. In the other case, aged 14 years, there was definite precocity of bone-age, and the external genital organs were over-developed for the patient's age.

The scope of this disease is not clearly defined. Albright et al (1937) review 13 cases of bone dysplasia of a similar kind recorded in the literature from 1922 onwards. Some of these cases exhibited the complete syndrome, while in others one or two of the triad of symptoms were absent, suggesting that the disease may occur in a less complete form than in the authors' own group of cases. Lichtenstein (1938) and Lichtenstein and Jaffe (1942) consider that the skeletal changes of the disease may occur in one, several, or many bones, and that fibrous osseous lesions with similar histology, localized to parts of single bones, may be regarded as representing a limited form of the disease. These authors emphasize the relative frequency of cases of mild or of moderate degree, which only rarely exhibit the extra-skeletal features of the syndrome. They review 90 cases of fibrous dysplasia of bone regarded by them as examples of the disease. In the majority the extra-skeletal signs were absent, and in their own experience of 23 cases, pigmentation of the skin was noted in only 2 cases, and only 2 of their female patients gave histories of precocious puberty. The reviews of Neller (1941) and Gorham et al (1942) include small groups of cases regarded as incomplete forms of the disease.

Thus, while the histological characters of the bone lesions described for Albright's syndrome cannot be regarded as specific for any one disease entity, examples of the complete syndrome with one or more of its characters poorly developed, and cases which, while falling short of the complete syndrome, exhibit osseous lesions in combination with precocious puberty or skin pigmentation, seem to constitute a series which leads on to examples of

the disease in which involvement of one or more parts of the skeleton is its sole manifestation

On the other hand, it seems probable that the disease may include, in individual cases, other features than the cardinal symptoms postulated by Albright et al (1937). Albright and his colleagues (1938) observed over-development of the external genital organs in one male subject aged 14 years

and treatment. At that time the case notes record a severe degree of bilateral knock-knee, the left worse than the right. The upper end of each tibia was enlarged and nodular. Unfortunately the radiographs are no longer available. A wedge osteotomy was performed on the left tibia and fibula, and union apparently took place normally. The result was considered to be satisfactory, but it was thought probable at the time that an osteotomy of the left femur would be required later on. In July,



FIGS 62 63 —Photographs showing the condition of the lower limbs on admission

Hyperthyroidism has been observed in some cases (Albright et al, 1938, Summerfeldt and Brown, 1939), and in one case recorded by McCune and Bruch (1937), and later by Sternberg and Joseph (1942), there was a history of thyrotoxicosis, and the autopsy findings included, in addition to hyperplasia of the thyroid gland, the thymus, and lymphoid tissue generally, basophilic adenoma of the pituitary, narrowing of the cortex and hypertrophy of the medulla of the adrenals, patent foramen ovale, and a Meckel's diverticulum. Multiple arteriovenous aneurysms involving the left upper extremity and probably the left lower extremity (Stauffer et al, 1941), co-arcuation of the aorta and a rudimentary left kidney (Lichtenstein and Jaffe, 1942), and probable congenital cardiac defect (Dockerty et al, 1945) have been observed in single cases.

The literature on the syndrome in its complete form has been reviewed by Neller (1941), and Gorham et al (1942), and Dockerty et al (1945) describe 6 more cases. These reviews include 39 cases of the syndrome in its complete form recorded in the literature.

We describe below an example of Albright's syndrome in its complete form, as it occurs in the male subject.

### CASE REPORT

**HISTORY**—R McK was born in August, 1921, apparently a normal baby except for a large "birth-mark" on his body. His parents, four brothers, and five sisters suffered from no deformity. At the age of 4 he was noticed to be knock-kneed, but medical advice was not sought until he was 9 years old, by which time the deformity had become considerably worse. In November, 1930, the patient was seen by Mr A J C Hamilton and admitted to the Royal Northern Infirmary for examination.

1931, the patient made this operation unnecessary by sustaining a fracture of the middle of the shaft of the left femur as the result of a relatively minor injury. The fracture united normally, but the deformities of his lower limbs grew steadily worse, until he ceased to be able to walk a year later. In spite of this, and although he fractured the right femur at the age of 15, twelve years elapsed before he next reported for examination at the Royal Northern Infirmary in January, 1943. By that time his deformities had become grotesque, and he was admitted to hospital for further investigation. Dr J F Brailsford, to whom radiographs were sent for an opinion, diagnosed polyostotic fibrous dysplasia.

The patient was referred to the Orthopaedic Unit, Raigmore E M S Hospital, for investigation and treatment on March 20, 1944.

**ON EXAMINATION**—At the time of his admission the patient was a rather pale young man, aged 22, of slender build and 115 lb weight. When seen sitting up in bed no obvious abnormality was apparent, but on turning down the bedclothes the most fantastic deformities of the lower limb were disclosed. No verbal description can do these deformities justice, but the photographs (Figs 62, 63) give a good impression of the legs below the knees. In addition there was gross bowing of the upper end of each femur, hyperextension deformities of both knees, and calcaneus deformities of both feet. The shaft of each tibia, in addition to its hairpin bend, was thickened. The range of movement in both knees and ankles was greater than normal, flexion of the hips was full, but abduction and rotation were restricted to a few degrees. The only other deformity which could be detected clinically was clubbing of the middle and ring fingers of the left hand.

There was, however, one other striking clinical feature, viz a very large area of brown pigmented skin covering the greater part of the left side of his body from the level of the iliac crest below to the nipple line above (see Figs 71, 72). In front this pigmentation did not extend beyond the midline, but posteriorly a band 2½ in wide extended across the midline around the right loin to the plane of the anterior superior spine.

**Cardiovascular system** The heart was enlarged and an apical systolic murmur was present. B.P. readings 135/60-140/70. Electrocardiograph Inversion of P 4. Slight tendency to right axis deviation.

There was no evidence of arteriovenous aneurysm or other vascular lesion.

**Central nervous system** No abnormality detected.

**Special senses** Visual fields normal.

**Reproductive system** The testicles were of normal size, and there was no secondary sex abnormality.

**X-ray Examination**—The whole of the skeleton was X-rayed and many unsuspected lesions revealed. The distribution of these lesions is indicated in Fig 64, from

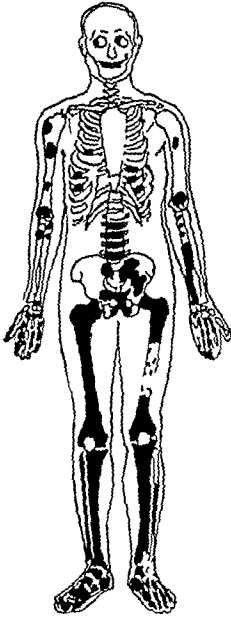


FIG 64—Diagram illustrating the distribution of osseous lesions. There was, in addition, a small area of the skull involved in the occipital region.

which it is clear that both sides of the body were equally affected, and that the lower half was far more seriously involved than the upper half.

In the most grossly affected bones, i.e. the tibiae, the whole of the shaft was involved (Fig 65) and showed the following features: deformity, expansion, thinning of cortex, decalcification, and a honeycomb of apparently cystic spaces of varying sizes.

In the femora, which were not quite so seriously affected, there were large areas showing similar changes but with areas of relatively normal bone lying between (Fig 66). In this radiograph a healed fracture of the shaft is seen.

Most of the other long bones of the body contained one or several cyst-like areas (Fig 67), the greater part of the shaft consisting of decalcified but otherwise normal bone. In some cases the cortex was expanded and very thin around these 'cysts'.

The pelvis, which was extensively affected, was distorted and compressed; the lower four lumbar vertebrae were crushed vertically; many of the bones of the hands (Fig 68) and feet showed all the features described in the tibiae, expansion being especially well demonstrated. In the skull only one area in the occipital region was affected.

The chest showed marked dilatation and some hypertrophy of the left ventricle, in addition to bone lesions in several of the ribs.

The kidneys showed no calculi, and uroselectan excretion was normal.

**BIOCHEMICAL AND OTHER DATA** (obtained during two periods of observation (1) from January to May, 1943, and (2) during October, 1945) —

January to May, 1943 —

Serum-calcium 9-10 mg/100 ml

Plasma inorganic phosphorus 1.08-1.58 mg/100 ml



FIG 65—Radiograph of right tibia and fibula, showing deformity, expansion, and cystic appearance.

FIG 66—Radiograph of the left femur, showing greatest involvement in the upper half. A healed fracture is shown in the middle of the shaft, and the bone in this region appears to be more nearly normal.

Serum-phosphatase 80 units (King-Armstrong) per 100 ml

Blood-urea 39 mg/100 ml

Urinary calcium excretion 0.12 g (as CaO)

Urea-concentration test normal range

Glucose-tolerance test blood-sugar curve normal;

a slightly low renal threshold for glucose

Hæmatological investigation normal results

Wassermann and Kahn reactions negative

Bence-Jones proteose in the urine on seven occasions during this period (March 11 to April 27) a trace of Bence-Jones proteose was present in the urine. A trace of albumin was also present.

October, 1945 —  
 Serum-calcium 9.2–9.6 mg /100 ml  
 Plasma inorganic phosphorus 2.0 mg /100 ml  
 Serum-phosphatase 50 units (King-Armstrong) per 100 ml  
 Blood-cholesterol 170–180 mg /100 ml

Urinary excretion, 0.24 g calcium  
 Faecal excretion, 0.77 g calcium  
 Basal metabolic rate + 10 per cent

**Treatment**—The general considerations on which the treatment of this patient were based are discussed later

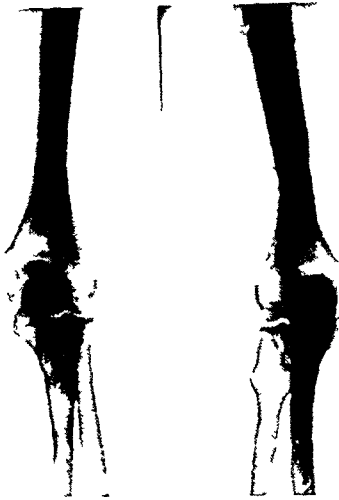


FIG 67—Radiograph of both elbows showing cyst-like areas of involvement. Note the expansion of the neck of the right radius.

Serum-proteins: Total protein 7.0 g per cent, albumin 5.2 g per cent, globulin 1.8 g per cent. (The above estimations were carried out on blood samples obtained while the patient was on a low-calcium diet of 0.1 g intake per day.)

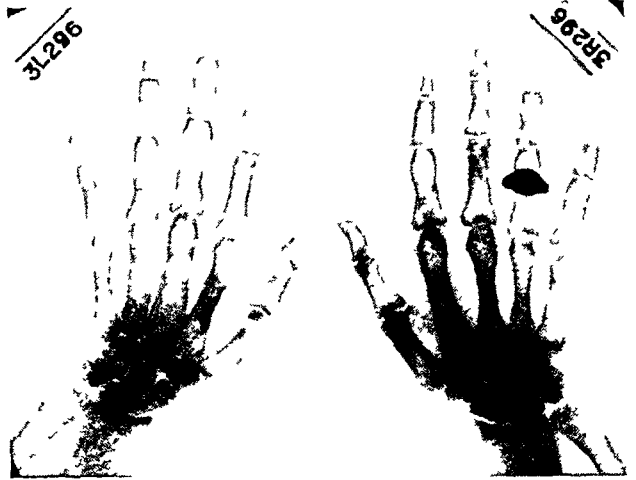


FIG 68—Radiograph of both hands, showing diffuse involvement of metacarpals and phalanges with expansion.

#### OPERATIVE TREATMENT —

**First Operation (April 1, 1944)**—*Osteotomy of Right Tibia and Fibula*. Subperiosteal exposure of the middle two-fourths of the right tibia and fibula. The fibula was found lying behind the tibia and, at its maximum convexity, actually medial to the tibia. Using an electric saw, about 3 in. of the fibula was excised, and rather more of the tibia. The soft tissues were freed subperiosteally



A



B

FIG 69—A Appearance of left leg at operation after subperiosteal exposure of the tibia and fibula. The dense white fibula contrasts strongly with the darker, rounded tibia, which lies in front of it. B, Satisfactory alignment after osteotomy.

Two calcium balance experiments were carried out during this period —

a For a period of four days on a daily intake of 0.1 g calcium

There was a negative balance of 0.49 g calcium

Urinary excretion, 0.64 g calcium

Faecal excretion, 0.25 g calcium

b For a period of three days on a daily intake of 0.5 g calcium

There was a positive balance of 0.49 g calcium

for 2 or 3 in. on the concave side of the bone ends, which then fitted together in reasonable alignment.

During the operation it was noted that the consistency of the bone varied very considerably. In some places it cut like normal bone, but in most places it was very easy to cut, especially where there were cyst-like spaces filled with what appeared to be fibrous tissue. Overlying these 'cysts' the cortical bone was very thin, but elsewhere the whole thickness of the shaft was of a homogeneous consistency without obvious distinction between cortex

and cancellous bone, and indeed without a medullary cavity. In these homogeneous areas the density of the bone was less than normal, solid but porous, and cutting quite easily.

Three to 4 in. of length were lost by this operation, and it was found necessary to excise a large piece of skin before closing the wound. The limb was then immobilized in plaster.

Rather surprisingly, no complications followed this operation, the circulation in the foot was not impaired, the patient had little pain, and the wound healed by first intention.



FIG. 70—Appearance of the lower limbs after union of osteotomies.

**Second Operation (April 18)—Osteotomy of Left Tibia and Fibula.** This operation was carried out in a similar manner to the previous operation. The tibia was found to be even more affected than in the right leg, and for 3 in. of its length consisted only of a thin cortical shell filled with a soft yellowish-brown material. The fibula, on the other hand, appeared to be of normal texture, and its smooth white hard surface contrasted strongly with the rough, pinkish, and yielding surface of the tibia (Fig. 69, A, B). About 4 in. of both bones was excised with good correction and after this the fibula acted as a strong bony buttress behind the tibia.

This operation was followed by pyrexia, which subsided after aspiration of a hematoma. No other complication was experienced, and the wound healed satisfactorily.

**Third Operation (May 26)—Osteotomy of Right Femur.** The bowed upper end of the femur was divided in two places 3 in. apart, and small wedges of bone were removed. The adductors were divided and the limb was immobilized in a Thomas splint with adhesive strapping extension tied to the end of the splint, which was fixed in wide abduction.

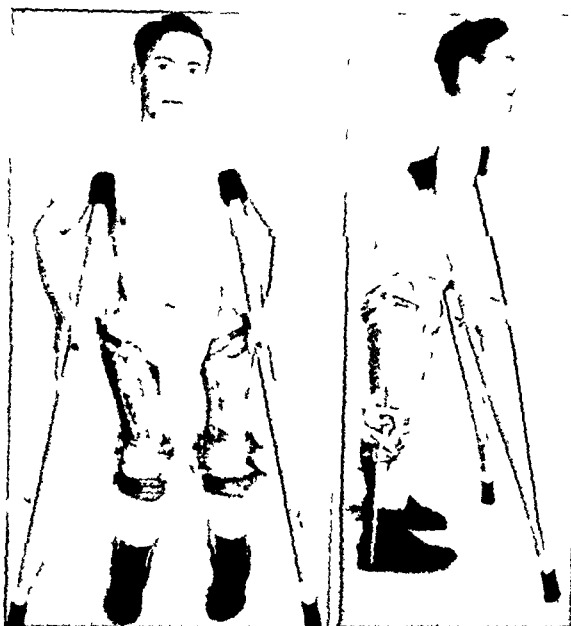
**Fourth Operation (June 10)—Osteotomy of Left Femur.** This was carried out as in the previous operation. In this leg the periosteum and bone were extremely vascular and bleeding was difficult to control. A Thomas splint again was used, both legs now being in extreme abduction.

**POST-OPERATIVE TREATMENT.**—By immobilizing in Thomas splints with strapping extension it was possible

to obtain further correction of the femoral and tibial deformities by moulding, pads, and slings. When it was considered that maximal correction had been obtained, plaster-of-Paris was applied over the top of the adhesive strapping extensions, and the use of the Thomas splints continued.

On Aug. 14 the limbs were examined out of plaster and all the osteotomy sites were found to be sufficiently firm clinically to allow exercises (Fig. 70). Splintage between exercises, however, was continued for several months.

On Jan. 19, 1945, the patient was fitted with corset-topped callipers, hinged at the knees, and began to walk.



FIGS. 71, 72—Photographs showing the patient after correction of the deformities, standing in his callipers. Note areas of pigmentation.

He made such good progress that he was allowed home after a few weeks, but two months later was re-admitted complaining of pain in the left thigh, and radiographs showed an incomplete fracture of the lower end of this shaft. It was evident that the callipers were not taking sufficient weight, and tuber-bearing rings were therefore added. Since then his progress has been satisfactory, and he is now able to get about quite well with the aid of sticks. The photographs show him standing in his apparatus (Figs. 71, 72).

Recently aluminium therapy as advocated by Helfert (1940) has been carried out, but insufficient time has elapsed to enable us to assess results.

#### Pathological Examination of Bone and Pigmented Skin—

**I. BONE** (removed from the right tibia and fibula on April 1, 1944, and from the right femur on May 26—

**Macroscopical Examination.**—The consistency and structure of normal bone was lacking. The tissue was soft and cut easily. In some parts it consisted of soft fibrous tissue, which felt 'gritty' to the touch, covered by a thin shell of cortical bone. In other parts much of the thickness of the specimens consisted of soft bone of a uniform, finely porous structure. Portions of the finer parts of the tibia and femur incinerated to demonstrate the architecture of the bone revealed striking changes from the structure of normal bone. There was no apparent differentiation into cortical and cancellous zones. The tissue from the tibia exhibited a fine, almost uniform

honeycomb structure, the tissue from the femur, areas of compact porous bone and areas of coarse and fine honeycomb structure. The tissue from the femur which was weighed before and after incineration

compared with incinerated bone taken from approximately the same level of a normal femur

*Histological Examination*—The normal structure of bone was replaced by numerous irregularly-formed,

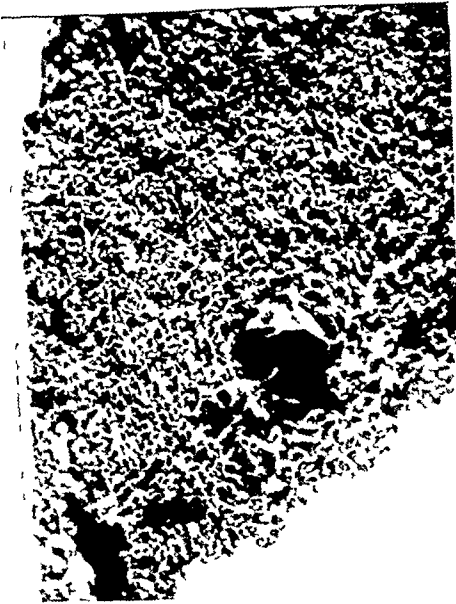


FIG 73—Bone from the right tibia, incinerated to demonstrate the architecture. Shows fine, almost uniform honeycomb structure without differentiation into compact and cancellous zones ( $\times 75$ )



FIG 74—Bone from a normal tibia at approximately the same level as the abnormal bone, incinerated to demonstrate the architecture ( $\times 75$ )

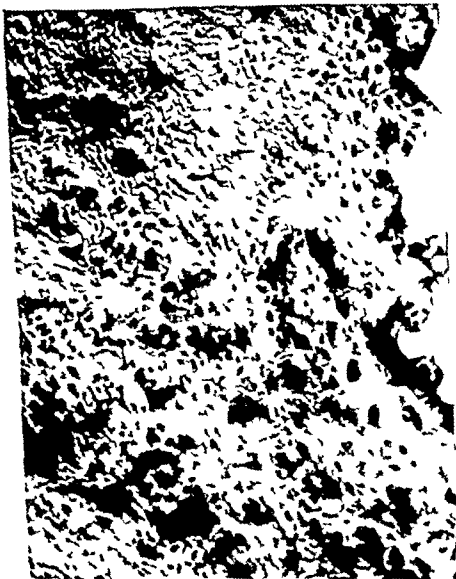


FIG 75—Bone from the right femur incinerated to demonstrate the architecture. Shows compact porous bone with areas of coarse and fine honeycomb structure ( $\times 75$ )



FIG 76—Bone from a normal femur at approximately the same level as the abnormal bone, incinerated to demonstrate the architecture ( $\times 75$ )

was composed of 62 per cent organic matter and 38 per cent mineral matter, as compared with 33 per cent organic matter and 67 per cent mineral matter of normal bone.

In Figs 73 and 74, incinerated bone from the tibia is compared with incinerated bone taken from approximately the same level of a normal tibia.

In Figs 75 and 76 incinerated bone from the femur is

imperfectly-calcified trabeculae of osteoid tissue in a matrix of cellular connective tissue. The cortical zone was extremely narrow. Bone formation and resorption were in active progress.

*a Cortical tissue* In the more active areas the cortex formed an interrupted zone. There was well-marked osteoblast and osteoclast activity and Haversian canals were widened. In the less active areas the cortical zone



was continuous, and in some parts there was a mosaic pattern due to irregularly disposed Haversian systems. The outer surface of the cortex was covered by a fairly wide zone of fibrous tissue

which osteoid tissue had been absorbed (Figs 77, 78). In adjacent areas young osteoid tissue appeared as numerous irregular trabeculae ringed with osteoblasts, with little or no deposition of calcium salts, osteoclasts

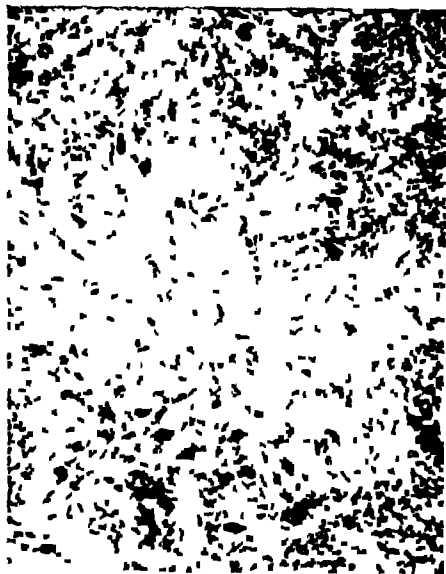


FIG 77—Section of active cellular area of osteitis fibrosa showing foci of commencing osteoid tissue formation and foci of giant cells ( $\times 525$ )

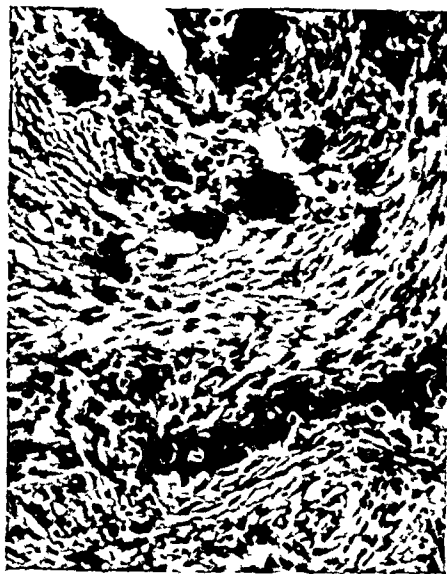


FIG 78—Higher magnification of a field depicted in Fig 77 ( $\times 150$ )



FIG 79—Section of area of osteitis fibrosa showing narrow irregular trabeculae of osteoid tissue. Matrix formed of more mature fibroblasts ( $\times 525$ )



FIG 80—Section of relatively quiescent area of osteitis fibrosa showing some calcification of central parts of trabeculae of osteoid tissue. Matrix more mature and fibrous ( $\times 525$ )

*b Deeper tissue* The structure varied with the consistency of the tissue examined, but in all parts bone formation and resorption were in progress. The softer parts were composed of a very active tissue consisting of a matrix of closely packed, plump, spindle-shaped cells with deeply staining nuclei, many small foci of osteoid tissue in process of formation, and groups of giant-cell, multinucleated osteoclasts often related to spaces from

were scanty and the matrix was composed of smaller, more mature fibroblasts (Fig 79). In firmer material, the tissue was relatively quiescent in appearance. The trabeculae were irregular but larger, with some deposition of calcium salts in their central parts, the matrix was more mature and fibrous (Fig 80). The tissue as a whole showed many thin-walled blood-vessels, and recent small haemorrhages were present in

the more cellular parts and no cartilage No 'foam-cells' were present, after osteotomy was not especially feared, for already osteotomy had been successfully carried out at the age of 9 years, and accidental fractures had united. The main doubt associated with osteotomy was whether it would be possible to correct the deformities of the tibiae without damage to the main vessels and nerves of the legs. There was also considerable doubt as to whether the bones of the lower limbs would be strong enough, after correction or amputation, to support the weight of the body. The problem was discussed with a surgical appliance

## DISCUSSION

In the case described above, the diagnosis of Albright's syndrome is based on the combination of progressive fibrous dysplasia of bone beginning early in life, the radiological and histological appearances of the osseous lesions, the absence of changes in the blood chemistry characteristic of parathyroid adenoma, and the presence of pigmentation of the skin. Pigmentation of the skin is more extensive on the left than on the right half of the body, and the history of the patient suggests that the earlier involvement of the skeleton was more marked on the left side. Unusual features exhibited by this case are (a) the low values for plasma inorganic phosphorus, (b) the presence of a trace of Bence-Jones proteose in the urine, and (c) in some parts of the cortical bone examined, a mosaic pattern due to the irregular disposition of Haversian systems. On two occasions in 1943 the values for plasma inorganic phosphorus were 1.08 and 1.58 mg/100 ml, respectively, and in October, 1945, the values were 2.0 mg/100 ml on two occasions. In the cases recorded in the literature, values for plasma inorganic phosphorus have usually fallen within the normal range, but low values have been observed occasionally (Albright et al., 1937, 1938). As far as we can ascertain, the presence of Bence-Jones proteose in the urine has not been previously observed in disease. Hummel (1934) recorded a mosaic pattern in bone from a male subject aged 11 years, but apparently this has not been observed in other cases. Calcium metabolism experiments were essentially normal, both on a low calcium intake of 0.1 mg calcium per day (Bauer et al., 1929), and on a basal intake of 0.5 mg calcium per day.

Radiological observation does not reveal extension of the disease to other parts of the skeleton during the past three years, and there are no notable changes to be observed in the existing lesions. However, the high plasma-phosphatase values during the same period point to a considerable degree of activity of the existing lesions, and this is borne out by the histological appearances of activity observed in tissue removed from the tibia and femur at operation.

**Treatment**—The ideal treatment of this case would consist of (1) treatment of the general condition with the object of restoring the bone to normal, and (2) correction of the deformities. With the exception of Helfer's (1940) aluminium therapy (discussed below), no hope of benefit from non-surgical treatment could be found in the literature. X-ray therapy had been tried in previous cases both on bone lesions and pituitary gland, but without any apparent effect (Albright et al., 1937). The patient's main concern was to be able to walk again. This could be achieved either by correcting the deformities or by amputating below the knees and fitting artificial legs. Non-union

maker, who expressed the view that he could make some form of calliper if the deformities of the thighs and legs were corrected sufficiently to bring the knees and feet into roughly the same vertical plane as the hips. It was decided, therefore, to attempt correction of one leg, and, if this failed, to carry out below-knee amputations, followed by osteotomies of the femora.

It is evident from the above operation reports that no serious complications followed osteotomy. Adequate correction was achieved by excision of a large amount of bone (3-4 in. of the tibiae) at the site of maximal deformity, and this, together with the wide subperiosteal stripping of soft tissues, ensured that the vessels and nerves were not unduly stretched. It appears, then, that correction of even the grossest deformities in long bones can be undertaken with safety if the surgeon is prepared to sacrifice sufficient length of bone.

It is further evident from this case, in which six osteotomies were performed through severely affected bones, that union does take place within affected time limits. This is true even when the osteotomy is through a 'cystic' area, as in the left tibia and the lower of the two left femoral osteotomy sites. Radiographs of the latter (Fig 8r) sixteen months after operation show a ring of sclerotic bone around



Fig 8r—Radiograph of the upper end of the femur, showing sclerosis around cyst through which osteotomy had been carried out sixteen months previously

the 'cyst', the contents of which probably remain soft and fibrous, unchanged and unossified. Judging by radiographs taken over a period of three years, there is no evidence that the soft contents of these 'cysts' are ever replaced by bone, they remain as constant points of weakness, liable to fracture, as demonstrated in this case by a fracture occurring as the result of weight-bearing through an old fracture site apparently united for twelve years.

It is suggested, therefore, that when an osteotomy is carried out through a cystic area it is advisable to excise the contents and fill with bone. The chief technical difficulty is likely to be in finding a suitable donor site, but in cases such as this where large wedges of bone are removed in order to correct deformity, sufficient bone from this source would probably be available to fill the cavity. It is now regretted that this procedure was not adopted in this case.

The fear regarding the capacity of the diseased bones to bear weight was justified when a fracture of the left femur occurred as the result of walking. The callipers worn at that time were corset-topped and consequently not sufficiently weight-bearing. Tuber-bearing rings, therefore, were added and during the past six months the patient has been walking, first with the aid of crutches and latterly sticks, and there has been no other sign of bone stress.

In planning further treatment, the hypothesis put forward by Helfet (1940) on the causation of generalized fibrocystic disease of bone, unassociated with parathyroid adenoma, and the treatment he has based on this hypothesis, are of great interest. According to this hypothesis, the secretory activity of the parathyroid glands is stimulated by the phosphate of the blood, and the bone lesions are the result of chronic hyperparathyroidism caused by chronic hyperphosphatæmia. The treatment consists of the administration of aluminium acetate or gluconate to precipitate a part of the phosphate of the bowel to prevent its absorption. In a small group of cases Helfet records good results with this treatment. The general condition of the patients improved and there was increase in the density of the bones. In one case for which calcium balance studies are recorded, there was a negative balance before and a positive balance after the commencement of treatment. Dockerty et al (1945) report some improvement with this treatment in one of their cases of Albright's syndrome.

In the case described above, the mechanism by which treatment which reduces the absorption of phosphate from the bowel might effect improvement is not apparent. The values for plasma inorganic phosphorus have tended to be low, and the values for calcium have been normal. However, in the biochemical data on his cases furnished by Helfet (1940), there are no abnormally high values for blood inorganic phosphorus, and in one case which derived considerable benefit from treatment with aluminium acetate, at one stage before treatment was begun the inorganic phosphorus was lower than normal.

**Ætiology**—Various theories have been advanced to explain the ætiology of Albright's syndrome. Albright and his colleagues (1937, 1938) regard the localization of the osseous lesions and their tendency

to unilateral distribution as precluding an endocrine or metabolic basis as the primary cause of the disease, and suggest that the symptoms may be an expression of an embryological defect or of a disseminated neurological disturbance, the gonadal anomaly resulting from afferent nerve impulses to the anterior pituitary. Lichtenstein and Jaffe (1942) believe that the malady has its basis in a defect of development, the skeletal changes resulting from perverted activity of the specific bone-forming mesenchyme. Sternberg and Joseph (1942) reject the idea that developmental defect alone can explain the dynamic sequence of events observed in the osseous lesions. They believe that the syndrome is the result of a complex endocrine disturbance, and that the progressive character of the bone lesions can only be explained on the basis of a disturbance in metabolism. These authors invoke the idea of a local tissue susceptibility to explain the tendency of the bone lesions to be unilateral in distribution, and cite instances of endocrine syndromes in which tissue changes have been predominantly unilateral. In Helfet's (1940) hypothesis, also, the underlying cause of the osseous changes in generalized fibrocystic disease is a general metabolic anomaly.

Apart from the gonadal dysfunction in female patients, evidence of endocrine disturbance has been lacking in the majority of the recorded cases of the disease, and we agree with those authors who believe that the syndrome can be best explained on the theory of a congenital anomaly as the basis of the disease. The recorded pathological studies and our own observations, however, lend little support to the view that the skeletal changes result from a primary perversion of activity of the specific bone-forming mesenchyme, and seem rather to indicate that they are secondary to some extra-skeletal disorder of calcium-phosphorus metabolism, a part of a congenital anomaly, with an incidental localizing mechanism, partly congenital and partly acquired. In parathyroid adenoma, in addition to the generalized decalcification of the skeleton, there are the multiple foci of excess of tissue change, the foci of osteitis fibrosa, which are presumably related to incidental factors of localization, and such incidental factors may be of a similar kind to those which determine the localization of the bone lesions in Albright's syndrome. It is difficult, however, to explain the tendency of the lesions in Albright's syndrome to be unilateral in distribution in the early stages of the disease and in the milder cases, and of the pigmentation to involve the skin of the side of the body predominantly affected with the bone changes, except on the assumption of some congenital peculiarity of organization of the tissues of bone and skin. In a wide field of pathology, variability in the functional quality of the walls of blood-vessels exercises a potent influence on the localization of disease, and apparently also on pigmentation of the skin (Burrows, 1932), and it may well be that localization of the foci of osteitis fibrosa in both parathyroid adenoma and Albright's syndrome is determined by a mechanism of this kind. In parathyroid adenoma a qualitative change in the walls of vessels acquired as a result of fortuitous events such as trauma and fresh stresses and strains resulting from initial lesions, in Albright's syndrome

similar changes which are partly congenital and partly acquired as the disease progresses

We wish to thank Mr A J C Hamilton and Dr Leys for permission to refer to clinical data concerning this patient while he was under their care in the Royal Northern Infirmary, Dr Gotlieb and the staffs of the Radiological Department of the Royal Northern Infirmary, and Raigmore Hospital, Mr T C Dodds, Edinburgh, for preparing the microphotographs, and the Medical Superintendent of Raigmore E M S Hospital, for permission to record the case

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## SACCULAR DIVERTICULOSIS OF THE JEJUNUM DUE TO RETICULUM-CELL SARCOMA

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DIVERTICULOSIS of the jejunum can be classified as primary and secondary. The former is purely a mucosal herniation through the musculature of the bowel wall. The diverticula are multiple and always spring from the concave or 'vascular' border of the bowel, and communicate with the bowel by a constricted neck at which the bowel musculature stops short. The case to be described is a rare type of diverticulosis occurring mainly in the third and fourth parts of the duodenum and the whole of the jejunum, being the result of multiple sarcomatous tumours in the wall of the gut.

#### CASE REPORT

**HISTORY**—The patient, Mrs J L, aged 70, was admitted to the Royal Salop Infirmary on June 6, 1945, with severe and continuous epigastric pain, persistent vomiting, and loss of weight.

She described herself as quite well until 1938, except for occasional attacks of diarrhoea and constipation, from which attacks she had suffered for a few years at infrequent intervals. In 1938 she developed severe epigastric pain, which was associated with persistent diarrhoea, but no vomiting. Her treatment at this time consisted of a daily enema for about three weeks, and gradually her symptoms disappeared. In 1943 she had a recurrence of symptoms. During the interval she was doing her full work and feeling quite well. In 1943 she was bombed out, her husband died, and her only son was sent overseas. Epigastric pain, passing through into the back, was the first feature. It was present every day and all day, and made worse by meals. Her appetite was poor and all food had a bad taste. There was no vomiting or eructation. She was admitted to Grimsby Hospital for five weeks. Diarrhoea was present at this time, and the diagnosis of carcinoma of colon was suspected. A barium enema and barium meal examinations were carried

out, and according to reports communicated there was no abnormality. During her stay at Grimsby Hospital her diarrhoea considerably improved on a fat-free diet and she was discharged.

In January, 1945, she again became ill with epigastric pain, which was associated with vomiting. This symptom was at first intermittent, but later became persistent, occurring one hour after meals, relief from pain followed the vomiting. There was no history of hæmatemesis. She stopped taking solid food towards the end of March and began taking Benger's, etc. Vomiting became less frequent and she lived principally on Benger's, milk, glucose, and olive oil, and also a few nutrient enemata. Diarrhoea was absent during this prolonged illness.

She was first seen by one of us (A G W) on June 5, 1945, and the diagnosis of subacute small-intestinal obstruction was made. Arrangements were made for her admission next morning to hospital.

**ON ADMISSION**—She was pale and dehydrated, and had obviously lost a good deal of weight. There was diffuse tenderness in the epigastrium. No mass could be felt, and there was no enlargement of the liver or spleen. Ascites was absent, and rectal examination revealed no abnormality. X-ray examination following a barium meal revealed the condition of multiple diverticulosis of the duodenum and jejunum (Fig 82). Soon after admission she received two pints of blood, following which she had a small reaction associated with a temperature and a rigor.

**AT OPERATION**—On June 8 an upper abdominal laparotomy was performed under nitrous oxide, oxygen, and ether. A quick examination revealed two areas of constriction in the upper jejunum.

The liver, gall-bladder, and stomach appeared normal. One of the large diverticula seen on X-ray examination was confirmed at operation. Attention was then paid to the jejunum with a view to resection. At a distance of 12 in from the duodenojejunal flexure the first stricture was located. The left border of the greater

omentum was adherent to the bowel. This was easily separated and an abnormal area of jejunum was found. The antimesenteric border for a distance of  $\frac{1}{2}$  in was "greyish-white" in colour and sacculated, and the wall was felt to have lost its muscle tone. The whole circumference of the bowel in this area was affected in the same manner. The distal end of this portion of the bowel was almost completely stenosed, and in its mesentery there was a small gland about  $\frac{1}{2}$  in in diameter, and about  $1\frac{1}{2}$  in from the serous coat. Proceeding about 12 in down the jejunum, a second pathological lesion was discovered. This consisted of a loop of bowel, two limbs of which were adherent to each other, and both were adherent to the mesocolon,



FIG 82.—Radiograph following a barium meal showing only the radiological appearances of multiple large and small diverticula of the duodenum and jejunum.

descending colon, and the lateral border of the great omentum. This latter was easily separated from the jejunum, which, in its turn, was easily freed from the mesocolon.

On further manipulation, the adherent loops of bowel were as easily separated, and a condition very similar to that described above was found in the proximal limb of this jejunal loop. In this instance, there was an added dimpling over the antimesenteric border, suggesting that at some date there had been a minute perforation. Present in the mesentery opposite this region was a large soft lymph-gland, approximately 2 in in diameter, and at a distance of 2 in from the bowel wall. It was decided that a resection of jejunum was necessary for double stricture of the bowel associated with diverticulosis, and appearances suggestive of malignant disease. A wide resection of 3 ft of jejunum from a point 5 in from the duodenojejunal flexure, including the mesentery and the affected lymph-glands, was performed, and an end-to-end anastomosis completed. This portion of gut included that part of jejunum adherent to the second affected limb.

**PROGRESS**—The patient made a remarkable, practically symptomless recovery. There was no vomiting or any other complication.

In four weeks she had obviously put on a fair amount of weight, and she was discharged to a convalescent home on July 10 in quite good condition. Here she remained for approximately four weeks, and came up to see me at my Out-patients' Department on Aug 20 looking extremely fit, and feeling so well that she had made the fifteen-mile journey alone. She said that she had not felt so well for many, many years, and her bowels were behaving excellently. On examination, she had no tenderness in the abdomen, but in the region of the anastomosis there was a suggestion of a swelling. There were no other swellings in the abdomen, and the liver and spleen were not palpable. There was no evidence of ascites, and the patient's physical condition was remarkably improved. A blood-count was done that day and showed a moderate degree of secondary anaemia with a normal white-cell count and differential. Arrangements were made for a barium meal and 'follow-through' examination to be carried out two days later. About one week later, inquiries were made regarding the result of the X-ray examination, and it was learned that the patient had not put in an appearance for that investigation.

Further inquiries disclosed that she was not well. On Sept 8 her doctor asked me to see her again. His opinion was that she had suffered a metastasis in the thoracic spine. Her state of health was very poor, and she had been suffering from severe root pains in the left side of her chest. Large doses of vitamin had been taken for the past ten days, but these were now losing their effect. Examination of the thoracic spine revealed some tenderness in the region of the 4th thoracic vertebra, and some slight lateral curvature in this region. Palpation of the abdomen revealed the same indefinite swelling that had been felt at her previous examination, but now the abdomen seemed more distended. She was extremely constipated, probably because of her vitamin, and she was admitted to a Nursing Home in Shrewsbury, and an X-ray examination of the spine and chest revealed a deformity in the region of the 4th thoracic vertebra, confirming the diagnosis of neoplasm. The lungs appeared healthy. With enemata and aperients, an action of the bowels was obtained, following which she became incontinent of feces and urine. She took very little fluid, was drowsy, and her condition deteriorated rapidly, culminating in death on Sept 12.

There had been neither vomiting nor signs of intestinal obstruction, and the exact cause of death was impossible to determine. A post-mortem examination was, unfortunately, not permitted.

**THE SPECIMEN**—This was 3 ft of small intestine, being comprised mainly of the jejunum. Scattered along the surface of an otherwise apparently normal bowel were many tuberoso swellings. Two large ones approximately 2 cm in diameter were situated proximally and they became progressively smaller towards the distal end of the jejunum. They were for the most part separate, but were sometimes confluent. They nowhere involved the whole circumference of the gut wall, and were not localized to any particular region of the wall. Thus, in this important respect they differed from the congenital type of diverticulosis. They were dull grey, and contrasted well with the rather congested bluish-grey colour of the normal gut. Where their junction with the normal gut occurred, it was common to see patches of deep purple congestion of an inflammatory reaction, covered by a thin fibrinous sheet.

The nodules were firm to touch, and there was an apparent increase in rigidity and slight stenosis of the bowel wall where the nodules abruptly joined normal bowel. This latter feature was markedly accentuated at two places approximately 12 in apart where a sacular

dilatation progressed into an almost complete stenosis of the bowel lumen. On opening the lumen of the gut these swellings were seen to be actual pouches, the wall of which was composed of thick white, firm, homogeneous

amount of mitotic activity, and these sheets of cells were spreading through the muscle layers and destroying them. The cells had oval poorly-staining nuclei, usually no nucleolus, and cytoplasm was scanty. They were



FIG 83—Photomicrograph showing the replacement of the circular and longitudinal muscle layers by the compact cellular sarcomatous growth. A few isolated strands of muscle can be seen within the tumour area ( $\times 40$ )

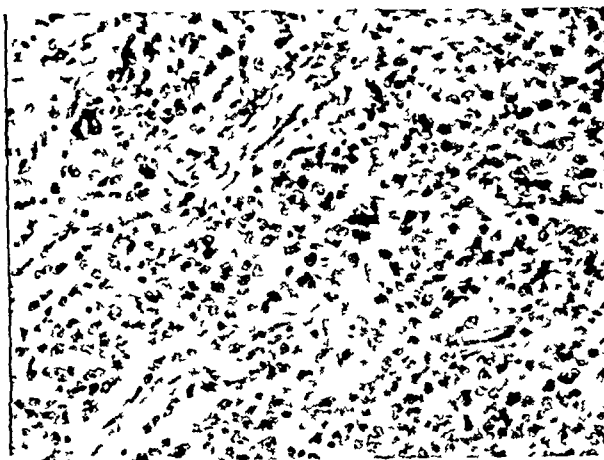


FIG 84—High power photograph showing the type of cell present in the growth ( $\times 200$ )



FIG 85—Showing the moderate reticulin formation within the tumour ( $\times 90$ )

tissue in which no muscle coat could be identified. The normal pale brown mucosal rugæ of the gut ended abruptly at the mouths of these pouches and gave way to a lining of pale yellowish-green slough. The floor of the pouches was coated with this soft granular debris. There were two enlarged encapsulated mesenteric lymph-nodes, one, by far the larger, measured 5 cm in diameter. This, on section, was a mere shell of solid tissue whose centre was a mass of creamy necrotic debris.

*Histological Description of the Diverticula*—The histological picture of all the separate diverticula suggested an infective granuloma, but was that of a reticulum-cell tumour confused partly by an inflammatory reaction consequent upon the mucosal necrosis and partly upon the cellular reaction to the proliferation of tumour cells.

In sections of the pouches the residual tumour formed a band of fairly even width, 0.3 cm approximately, situated sometimes in the line of, and replacing, the muscle coat, and where the whole wall had been eroded, forming a dome projecting from the serous surface. There was a marked proliferation of primitive reticulum cells tending to be formed in symplasma, with a fair



FIG 86—A low-power view of a section through the floor of one of the small pouches ( $\times 3\frac{1}{2}$ )

nowhere phagocytic, and formed a moderate amount of reticulin which was laid down in lines parallel to the blood-vessels. There were numerous eosinophils scattered amongst the reticulum cells, but no plasma cells or Sternberg-Reed giant cells. There was no collagen formation except at the periphery, where there was a zone of œdema, fibrosis, and lymphoid infiltration outside the tumour (Figs 83–86).

The large lymph-node showed none of the normal architecture of a gland. The main mass was composed of necrotic tissue containing abundant fragments of nuclear material. This was bounded by a narrow zone of reticulum cells, and outside this was a zone of fibrosis, dilated lymph-vessels, histiocytes, plasma cells, eosinophils, and lymphoid aggregates, gradually changing to fatty connective tissue.

### CONCLUSION

The degree of lack of differentiation of the cell-type, and the marked infiltration, coupled with stromal destruction, classified this tumour as a reticulum-cell sarcoma. The histological features described are common to both the dictyo-syncytial type and the polymorphic reticulum-celled type of growth (Robb-Smith, 1938).

### SURVEY OF LITERATURE

In the literature consulted, the terms 'lymphosarcoma' and 'lymphoblastoma' have been used freely to describe malignant conditions affecting lymph-nodes and lymph-follicles in the bowel. Only rarely has the histologically distinct reticulum-cell type of tumour been identified from the more usual malignant type of tumour composed of lymphocytes. However, the term 'lymphosarcoma' is used here in the 'Survey of Literature' only, to facilitate comparison with other recorded cases, but a pathological distinction exists and should be recognized.

'Lymphosarcoma' of the small intestine usually occurs in the ileum (Fraser, 1945). Sarcoma of the duodenum and jejunum appears to be rare.

Simpson-Smith (1939) reported 3 such cases in a series of 70 small-intestinal sarcomata. Morison's review (1941) of 2434 autopsies and 10,705 biopsy specimens yielded 21 primary tumours of the small intestine. Of these, 4 only were lymphosarcomata, and he described one case in which a lymphosarcoma of the duodenojejunal junction involved the whole circumference of the bowel and had produced saccular dilatation of the lumen. In the 126 cases of intestinal 'lymphosarcomata' collected by Ullman and Abeshouse (1932), the anatomical localization of the tumour was duodenum 4, duodenum plus jejunum 1, duodenum plus stomach 1. The rest were ileal and colonic. In 59 cases collected by Libman (1900) he found the duodenum and jejunum to be as common a site as the rest of the ileum. Cheever (1932), from an analysis of his own 16 cases, states that the frequency of incidence of 'lymphosarcoma' seems to increase with its distance from the stomach, and he found it to be rare in the duodenum and most common in the terminal ileum. Weinstein (1932) gives the order of occurrence in his cases as ileum, caecum, jejunum, transverse and sigmoid colon, duodenum, and descending colon. From an analysis of the published cases with regard to the age incidence of lymphosarcoma of the small intestine, this tumour seems to be rare in old age, and occurs commonly during the 1st, 3rd, and 4th decades.

### DISCUSSION

Primary malignant lymph-node tumours form an uncommon cause of intestinal obstruction, and

increase in the diameter of the intestinal lumen seems just as prone to occur as constriction. In the case described by Morison in which the tumour had produced a saccular dilatation of the lumen, the growth was solitary and X-ray examination had revealed nothing. Out of the series of Ullman and Abeshouse 18 lymph-node sarcomata showed dilatation which was in some cases described as aneurysmal, but in no case did the dilatations simulate multiple well-demarcated diverticula or give an X-ray picture remotely resembling one which appeared indistinguishable from the condition of multiple diverticulosis.

It may, in fairness, be inferred from the operative finding of a large aneurysmal bulging of the duodenal wall along its *antimesenteric* border, and from the X-ray picture, that the pouches seen in the duodenum were of the same nature as those described in the resected jejunum. The interest attached to the present case centres around the large number of pouches and the length of gut involved, the site of the sarcomata, and the X-ray findings before operation.

It is suggested that from the beginning the tumour was multicentric and had its origin in the reticulum cells of the lymph-follicles within the submucous layer of the duodenum and jejunum. These probably formed rounded globular tumours which underwent central necrosis, subsequent mucosal sloughing completed the picture of ulceration. These are pathological pouches or 'tumour diverticula' the creation of which can be imagined from the histological description. The tumour destroys stroma, does not form collagen save in very small amounts, and has the effect of weakening and destroying the muscle wall, it may so cause dilatation. Further, paralysis of the remaining muscle may be brought about by the destruction of its nerve plexus, and thus a localized organically weakened wall, coupled with obstruction, would be subject to a raised intraduodenal pressure.

### SUMMARY

A condition of 'secondary' diverticulosis of the duodenum and jejunum has been described. The aetiology of the diverticula was multiple reticulum-cell sarcomata originating in the submucous lymph-follicles.

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## A FURTHER REVIEW OF THE INTERINNO-MINO-ABDOMINAL OPERATION, BASED ON 21 PERSONAL CASES

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ONE of the authors (G G-T) has already published two contributions on the interinnomino-abdominal amputation in the columns of the BRITISH JOURNAL OF SURGERY, but the completion of 21 operations in the past 23 years seems to call for a note on any modifications in technique which experience has dictated in the hope that the suggestions may be of value to others called upon to practise the amputation. An attempt has also been made to collect all the hind-quarter amputations that have been performed during the 11 years that have elapsed since Philip Wiles and one of the writers (G G-T) made a similar collection up to 1935. Some information is also forthcoming as to the type of case most likely to benefit by this amputation in respect of cure or material prolongation of life. In the performance of the last 10 operations the writers have had the good fortune to work together on 8 occasions, and only 2 of these 10 patients have succumbed from the amputation. Nevertheless, our own total fatality-rate is higher than that of all the published cases collected during the past 11 years which form the basis for some of the conclusions set forth in this paper. The recovery-rate of the past 10 cases (80 per cent) is some improvement on the 64 per cent recovery recorded by one of the authors (G G-T) in his paper published in 1940, yet operative mortality may often be an index of a readiness to help to the utmost those suffering from a radio-resistant tumour, whom heroic surgery alone can save, and is not to be regarded as a reflection on surgical judgement or operative skill.

### PERSONAL CASES (G G-T)

Cases 1-5 were given in detail in the BRITISH JOURNAL OF SURGERY, 1935, 22, 672

**Case 1—Sarcoma of upper end of femur with involvement of innominate bone**

Operation, July 27, 1922. Death a few hours after operation

**Case 2—Osteoclastoma involving whole structure of innominate bone**

Operation, Feb 4, 1929. Patient in excellent health 17 years later

**Case 3—Enormous chondrosarcoma of innominate bone, overlapping upper end of femur and extending to costal arch**

Operation, Nov 5, 1933. Death, October, 1938, of recurrence

**Case 4—Sarcoma of pelvis**

Operation, March 3, 1934. Death after operation

**Case 5—Osteogenic sarcoma of upper end of femur**

Operation, July 2, 1934. Recovery. Patient is said to have died of pneumonia less than a year after amputation. It is difficult to exclude a thoracic metastasis

Cases 6-11 were given in some detail in the BRITISH JOURNAL OF SURGERY, 1940, 27, 643

**Case 6—Spindle-celled sarcoma of muscles of Scarpa's triangle**

Operation, June, 1935. Patient alive and well more than 11 years later

**Case 7—Osteolytic sarcoma of iliac portion of right innominate bone, pathological fracture of acetabulum**

Operation. Death a few hours after

**Case 8—Spindle-celled sarcoma of muscles of Scarpa's triangle**

Operation. Recovery. Death, probably from recurrence, 5 years later

**Case 9—Sarcoma of right innominate bone**

Operation. Recovery. Death from recurrence 6 months later

**Case 10—Spindle-celled sarcoma of psoas muscle**

Amputation September, 1938. Death after operation

**Case 11—Chondrosarcoma of left innominate bone. Operation. Recovery**

Operation, Aug 19, 1939. Patient alive and free from recurrences nearly 7 years later

**Case 12—Myxosarcoma of ilium. Hindquarter amputation. Death from recurrence 15 weeks after operation**

Betty H, aged 25, had sustained a fall on her back a year before admission to hospital, she had suffered pain down the back of the leg to the ankle for six months previous to admission, and had noticed a lump for three months. The swelling was about  $3\frac{1}{2}$  in in diameter, hard and homogeneous, arising from the dorsum ilii just below the iliac crest, the tumour was also palpable in the left iliac fossa. A biopsy on Aug 26, 1942, showed the growth to be "a moderately cellular spindle-cell sarcoma, in which is considerable myxomatous degeneration."

She was transferred to the Radiotherapy Department, and was under treatment from Aug 31 to Sept 14, 1942, but the neoplasm proved to be radio-resistant, and the pain gradually intensified to an agony.

There was no clinical or X-ray evidence of metastases, the posterior situation of the neoplasm in reference to the innominate bone was not attractive from the standpoint of surgery, but the pain and distress from which the girl was suffering determined us to perform a hind-quarter amputation on Sept 19, 1942. The operation was carried out according to the technique described fully in a previous communication (Gordon-Taylor and Wiles, 1935). The girl stood the operation remarkably well, blood-loss was minimal, there was scarcely any rise of pulse-rate or fall of blood-pressure, a pint of blood was transfused during the operation. The posterior and inward extension of the growth demanded the removal of the left ala of the sacrum in addition to the innominate bone (Fig 87). Some difficulty was obtained in covering the wound with integument, the position and size of the tumour precluding the fashioning of any posterior flap.



The operation relieved the agony from which the patient had suffered, but although she was able to get up she made indifferent progress, and three months after her operation local recurrence of the neoplasm was only too apparent, and she finally succumbed from the combined effects of the growth, toxæmia, and secondary hæmorrhage 15 weeks after amputation

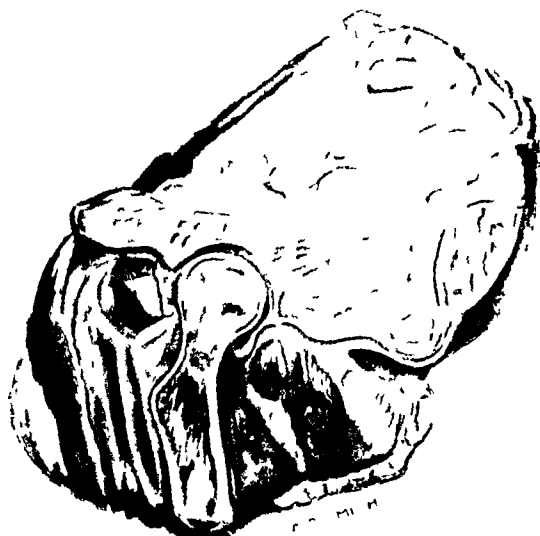


FIG 87—Case 12. Specimen after hindquarter amputation, whole os innominatum and ala of sacrum are involved in the growth, the body of the ilium being replaced by a thick gelatinous mass with small areas of bone embedded in it. Sections showed a moderately cellular myxosarcoma, the sacro-iliac joint was invaded by growth

**Case 13—Recurrent spindle-cell sarcoma of Scarpa's triangle. Interinnomino-abdominal amputation. Death from thoracic metastasis 13 weeks after amputation**

Captain L. P. M. C., R. A., aged 43. 'Reported sick' in February, 1942, to the medical officer of his unit, complaining of pain in the medial aspect of the upper thigh. Two months elapsed before the diagnosis of a neoplasm was definitely established, and in April, 1942, a local excision of the tumour in Scarpa's triangle was performed by an able surgeon attached to a hospital of great tradition. The officer subsequently attended the radiotherapy department of that same institution for 3 weeks.

Six months later, recurrent swelling and continuous pain brought the officer again to the original surgeon and radiotherapist, a reluctant decision was given that nothing further could be done. One of the present writers (G. G.-T.) was subsequently invited to see the officer, and expressed the opinion that a hindquarter amputation might still save his life. No clinical or X-ray evidence of secondary growth was forthcoming, and accordingly on Oct. 17, 1942, a hindquarter amputation was undertaken.

**OPERATION**—The operation was carried out according to the technique described fully in a previous communication, the anterior situation of the growth permitted the retention of the auricular surface and articular portion of the posterior segment of the ilium (Fig. 88).

The poor fellow's early convalescence was by no means uneventful, since he first developed acute dilatation of the stomach, which required a Ryle's tube, he then had pneumonia, followed by hæmaturia and urinary suppression consequent on sulphapyridine exhibition.

The devoted care of Surgeon-Lieutenant John Ferguson, M.B.E., R.N.V.R., and the patient's own wonderful spirit enabled him to surmount these difficulties.

He was able to get about on crutches until 12 weeks from his operation, when two or three suspicious nodules were noticed in the neighbourhood of the scar, in two days' time these had doubled their size and number, leaving no doubt as to their sinister significance. In another two days a pleural effusion of blood-stained



FIG 88—Case 13. Photograph of hindquarter amputation for a recurrent spindle celled sarcoma of muscles of Scarpa's triangle

fluid was found, and the end rapidly came, death resulting within a week of the appearance of the suspicious nodules (!) No post-mortem examination was performed. The histological appearances of the tumour were those of a spindle-celled sarcoma.

**Case 14—Cellular spindle-celled sarcoma, possibly originating from synovial membrane. Hindquarter amputation. Death from pulmonary embolism**

Albert B., 39, had noticed a painless swelling in the upper part of the left thigh for three months before admission to the Cambridge Hospital, Aldershot. A biopsy revealed the presence of an undifferentiated sarcoma. The patient was transferred to the Middlesex Hospital for radiotherapy, which was commenced on July 27, 1942, and the course was completed in 23 treatments spread over 30 days. On Jan. 19, 1943, there were large necrotic ulcers in the groin, a biopsy report was highly suggestive of a radio-resistant fibrosarcoma. In view of the intractable pain and the continuance of the malignant process, a hindquarter amputation was advised, and the patient was transferred to our care. The early period after operation, performed March 12, 1943, was complicated by acute sulphonamide hæmaturia, which cleared up on the administration of sodium sulphate. A few days later the patient suddenly died from what was regarded as a pulmonary embolus. No post-mortem was obtained.

**Case 15—Spindle-celled sarcoma of ilium. Hindquarter amputation. Death**

Percy N., aged 54. Pain in left groin on walking since July, 1942. Massage, radiant heat, and manipulation in other institutions proved unavailing. Admitted to Middlesex Hospital, March 13, 1943. Biopsy revealed the tumour to be a cellular spindle-celled sarcoma with little collagen formation. Hindquarter amputation, April 6, 1943, at operation, the growth was found to extend much farther back than was anticipated, and even to involve the bifurcation of the common iliac artery. The operation was completed not without difficulty. Death ensued six hours after.

**Case 16—Fibrosarcoma. Hindquarter amputation. Recovery**

A nurse between 50 and 60 years was referred to one of us (G. G.-T.) by Mr. H. L.-C. Wood, of King's

College Hospital, for a voluminous tumour on the inner aspect of the uppermost part of the thigh, bulging anteriorly and posteriorly. Biopsy showed a tumour of fibrosarcomatous type. With the able assistance of Mr H L-C Wood, a hindquarter amputation was performed in June, 1944, Dr H A Richards administering an ordinary general anaesthetic of gas, oxygen, and



FIG 89—Case 16 Huge spindle celled sarcoma of muscles of the inner aspect of the root of the left thigh, tumour bulging in the gluteal region and adductor region of the thigh. Female patient between 50 and 60 years of age. A lymphatic gland along the external iliac vessels was found to be infected with growth on examination of the specimen

ether. The patient made a good recovery from the amputation, but unfortunately an infected gland was found along the course of the iliac vessels. The patient succumbed from pulmonary metastases four months later.

The specimen was reported by Dr R W Scarff as a cellular spindle-celled sarcoma with areas suggestive of an origin in fascial sheath (Fig 89).

**Case 17—Myxochondrosarcoma arising in trochanteric region in right femur. Death from recurrence 18 months later.**

Alfred F, aged 47. For 16 months previous to admission he had complained of pain in the right buttock and "sciatica". Seven months before admission to Middlesex Hospital the sciatic nerve was stretched in another institution, but without relief, the patient was now confined to bed by the severity of the pain. A radiograph was ultimately taken, demonstrating a "mass at the upper end of the femur". After a preliminary biopsy, a hindquarter amputation was performed on Nov 27, 1943. The patient made a good recovery from the operation, but died from local and pulmonary metastases, June 10, 1945 (Fig 90).



FIG 90—Case 17 Photograph of hindquarter amputation for a myxochondrosarcoma arising in the trochanteric region of the right femur, a pathological fracture at the base of the femoral neck is present

**Case 18—Osteogenic sarcoma of trochanteric region of right femur. Pregnancy. Recovery.**

Doris P, aged 27. First complained of pain in right hip six months before admission to Middlesex Hospital. She was treated in several other institutions, firstly on a mistaken diagnosis of tuberculosis of the hip, and later as a sarcoma of the upper end of the femur, for which X-ray therapy was considered. The radiographic appearances of the mass (Fig 91) negated any prospective benefit from deep-ray therapy. The patient was seven months' pregnant.

It was recommended by one of us (G G-T) that the pregnancy be terminated and the patient admitted to Middlesex Hospital. Biopsy showed the new growth to be an osteogenic sarcoma. Hindquarter amputation performed in Middlesex Hospital, Dec 19, 1944 (Fig 92). Patient discharged six weeks later, walking satisfactorily on crutches, wound soundly healed. Well 18 months later.

**Case 19—Infiltrating chondroma of pubic bone. Hindquarter amputation. Recovery.**

Herbert H, 26, first noticed pain in right hip in January, 1945, and a mass was felt in the right groin and was also palpable on rectal examination. Radiographs showed the presence of a chondroma growing from the pubic ramus. The situation of the tumour and especially its proximity to the hip-joint seemed to negative the chances of total eradication of the neoplasm by any local removal, and a decision to perform a hindquarter amputation was made after mature deliberation and consultation with colleagues. Interinnomino-abdominal operation performed May 3, 1945 (Fig 93). A good recovery followed, save that pains of a "phantom limb" were complained of, gradually diminishing in severity.



FIG 91—Case 18 Radiograph of osteogenic sarcoma of the neck and trochanteric region of the right femur Seven months pregnancy



FIG 92—Case 18 Osteogenic sarcoma involving the neck and upper quarter of the shaft of the right femur The patient had a seven months pregnancy terminated before the performance of a hindquarter amputation



FIG 93—C a lobulated cartilaginous tumour composed of atypical cartilage, there is no evidence of bone formation by the tumour

#### Case 20—Myosarcoma of left thigh Hindquarter operation Recovery

Regina W, aged 52, a Polish lady, first noticed a lump about the size of a walnut in December, 1943, since then the tumour had grown steadily, but pain was only experienced on firm pressure and radiated down the back of the whole leg. In June, 1944, a biopsy showed the tumour to be a spindle-celled sarcoma originating in muscle. In July, 1944, a course of deep-ray therapy was given, 24 treatments were spread over 29 days. In March, 1945, there was a reappearance of the lump and a renewal of the pain, April and May, 1945, more X-ray therapy was administered. The tumour appeared radio-resistant, and on June 13, 1945, measured about 5 in in diameter, and was raised about 1 in above the surrounding skin. A consultation was held as to the desirability of an amputation at the hip-joint or a hindquarter amputation. The prospects of a thorough extirpation seemed to be brighter from the latter operation, inasmuch as there seemed to be considerable involvement of the muscles inserted into the great trochanter. Hindquarter amputation was performed, June, 1945. Recovery. The tumour was a myosarcoma, the appearances of the spindle-celled tumour suggest an origin in muscle, there are large areas of necrosis present. Patient free from recurrence a year later.

### Case 21—Chondrosarcoma of innominate bone. Interinnomino-abdominal amputation Recovery

E K, male, aged 39, was admitted into Charing Cross Hospital under the care of Dr Lennox R Broster for a large tumour of the innominate bone bulging the gluteal region. The tumour was said to be growing rapidly and certainly its dimensions increased considerably during the fortnight of pre-operative investigation and preparation which preceded his amputation.

Operation, March 1, 1946, Charing Cross Hospital (G & T). Dr L R Broster ably assisted, unilateral spinal and general anaesthetic administered by Dr R J Clausen. The usual operation technique was followed, but the involvement of the gluteal muscles prevented the fashioning of any posterior flap, and the wound could not be entirely covered by the integument. The patient made an excellent recovery.

Dr R W Scarff, of the Bland-Sutton Institute, Middlesex Hospital, reported the tumour as a chondrosarcoma.

### TECHNIQUE OF THE OPERATION

This was fully described by one of us in the *BRITISH JOURNAL OF SURGERY* eleven years ago, and the lines of the operation have been followed pretty closely in the intervening years. In the first communication tribute was paid to the excellence of Hogarth Pringle's account of the amputation published 30 years ago in this *JOURNAL*, our homage to the Glasgow surgeon's work has not lessened with the passage of time.

**Anæsthesia**—In 20 out of 21 amputations on which this communication has been written spinal anæsthesia has been employed in conjunction with general anæsthesia, but whereas stovaine used to be employed, a unilateral (ipsilateral) injection of 10 cc of 1-1500 nupercaine is now practised. Pentothal (g  $\frac{1}{4}$ ), nitrous oxide, oxygen, and minimal amounts of ether have been administered. In one case, despite the protest of the surgeon, no spinal anæsthetic was used, and the operation was completed under gas, oxygen, and ether (Dr Hugh A Richards). Perhaps no hindquarter amputation ever left the operation room in better condition (!) The 'spinal', then, is not a necessary adjunct, yet we find difficult to abandon a technique which has been used with a considerable measure of success for many years.

**Position**—Emphasis was laid ten years ago on the most gentle care which should be taken in turning the patient, the danger from rough or excessive movement of a patient under spinal anæsthesia is not to be estimated lightly. Nowadays we carry out the iliac, inguinal, pubic, and gluteal portions of the operation with the patient much more in the true lateral position than formerly, the uppermost arm being placed in the usual kidney arm-rest. The surgeon leaning over the patient can perform all the necessary dissection, including the division of the dorsum ili, with the subject in this position. The case is only very gently turned on to his back for the division of the symphysis pubis and the completion of the severance of the half pelvic ring and lower limb from the rest of the body. We have found that the amputation has been facilitated by dividing the dorsum ili before the symphysis pubis, and the bone section is best done with a Gigli's saw after securing the posterior division of the internal iliac artery and a transverse division of the psoas muscle

at the pelvic brim. We have usually divided the external iliac artery distal to the origin of the deep (inferior) epigastric and deep circumflex iliac arteries, so that the vascular supply of the rectus abdominis and flat muscles of the abdominal wall is not interfered with, these structures are destined for suture to the gluteal muscles, constituting a muscular stratum between parietal peritoneum and skin. Time is well spent in securing control of the posterior division of the internal iliac artery. In those cases where the position of the tumour or other circumstances render ligation of this artery impossible or only practicable after the expenditure of much time, a temporary clamp on the common iliac artery (arterial clamp, tape, etc.), as suggested to us by Basil Hume, is a most valuable procedure.

There is no need to mention the retention of a catheter during and after the operation, nor is there any necessity to stress the importance of adequate supplies of blood at hand. In many cases only a pint has been required during the actual performance of the amputation, but transfusion will certainly be required later on.

The impertinent intrusion of the anus into the field of operation during the stage of suturing the flaps called for some measure to conceal it, and the orifice is nowadays sealed off from the gaze of the operator and the spectators by means of a piece of cellophane or green protective appropriately retained in position by means of sutures.

In our hands about an hour and five to ten minutes constitutes the customary length of time to complete the operation, although we have finished in just under the hour. In the skilful hands of Professor Harry Platt, of Manchester, a much shorter time has often sufficed, but a perusal of the accounts written by others who have performed the amputation persuades us that we ourselves are not sluggards, and that anxiety to return the limbless patient to his bed must burn more fiercely in our breast than in most of those, perhaps with more ample time at their disposal, who have embarked upon the procedure.

### After-treatment—

- 1 Bed—sorbo mattress and water-pillow or full-length water-bed
- 2 Electric cradle and blankets—warm jacket
- 3 Sandbag to support hip
- 4 Remove blocks from under foot of bed gradually as soon as condition permits
- 5 Commence breathing exercises as soon as patient is round from anaesthetic
- 6 When patient's back is receiving attention, patient must be rolled on to both sides
- 7 Slide sandbag under loin to keep pressure off bottom of the wound, when patient is being turned on to the side of the amputation
- 8 Remember the heel
- 9 Glycerin enema on second day and thereafter on alternate days
- 10 This is not a cosmetic operation, premature removal of sutures is forbidden and will lead to the dismissal of house surgeon or nurse after much obloquy
- 11 First dressing may be done under pentothal, when the drain will be removed

Table I—DETAILS OF INTERINNO-MINO-ABDOMINAL AMPUTATION RECORDED IN LITERATURE OR KNOWN TO AUTHORS SINCE 1935 (73 IN NUMBER)

SURGEON	SEX AND AGE OF PATIENT	DISEASE	RESULT OF OPERATION	REMARKS
Bailey, Hamilton (Great Northern Hospital, London (1937)	Female, 22	Periosteal sarcoma of pubic bone	Recovery	Lived 2 years after operation—died of thoracic disease (!)
Banet, V, and Nobo, P (1936)	Male, 27	Fibrosarcoma of upper end of left femur	Recovery	Late result unknown <i>Bol Liga Cancer, Habana, 1936, 11, 43</i>
Brittain, H A, Norwich, (1941)	Male	Malignant chondrosarcoma of dorsum ilii of large dimensions	Recovery	No recurrence at 4 years
Brittain, H A, Norwich, (1945)	Female	Osteogenic sarcoma of upper third of femur with new bone formation	Recovery	
Christmann, F E, and Cingano, C A	Male, 30	Hydatid disease of pelvic bones	Recovery	Death 1 year later <i>Bol Trab Acad Argent Cir, 1944, 28, 119</i>
Clarke, H Osmond, Air Commodore (1945)	Male	Sarcoma of abductive region	Recovery	
Davison, T C (1920)	Male, 70	Extensive cancer of skin of groin following burn in infancy	Recovery	Survived 7 years and no recurrence
Deitch, H I, Bradford (1941)	Male	Chondrosarcoma of upper end of femur Pathological fracture	Recovery	Alive and well 5 years later
Fierro, D Fernandez (1937)	Female middle aged	Sarcoma of femur, with a metastasis in ilium of same side	Recovery	Patient alive several months later <i>J int Coll Surg, 1943, 6, 368</i>
Fitzgerald, R R, Montreal, (1936)	Male 13	Osteogenic sarcoma of neck of femur	Recovery	<i>J Bone Jt Surg, 1936, 18, 402</i>
Fitzwilliams, D C L	Male, 62	Rhabdomyosarcoma of vastus medialis	Recovery	Death from secondary sarcoma a few months later <i>Proc R Soc Med, 1938, 31, 548</i>
Gersh, L Y (1936)	Male, 60	Sarcoma of head and neck of femur	Death from infection of wound	Secondary growths found at autopsy <i>Soviet Khir, 1936, 4, 681</i>
Girdlestone, G R, Oxford (1941)	Male, 44	Osteogenic sarcoma of ilium	Recovery	Personal communication Alive and well 5 years later
Ghormley, R K, Henderson, M S, and Lipscomb, P R (1943), 2 cases	Male 56	Chondrosarcoma of innominate bone—with pathological fracture	No recurrence at 7 months	<i>Proc Mayo Clin, 1944, 19, 193</i>
	Male, 50	Chondroma of ilium, infiltrating acetabulum and head of femur	No recurrence at 2 months	
Gordon-Taylor, G (1935)	Male, 17	Spindle cell sarcoma of muscles of Scarpa's triangle	Alive and well at 10½ years	
Gordon-Taylor, G (1936)	Female, 25	Spindle-cell sarcoma of Scarpa's triangle	Recovery	Death—probably from recurrence 5 years later
Gordon-Taylor, G (1937)	Female, 37	Osteolytic sarcoma of iliac portion of innominate bone	Death within a few hours	A diminutive woman—only 4 st in weight
Gordon-Taylor, G (1938)	Male, 34	Spindle-cell sarcoma of right psoas	Death 24 hours after operation	
Gordon Taylor, G (1938)	Male, 14	Sarcoma of right innominate bone	Recovery	Death from recurrence in spine 6 months after operation
Gordon-Taylor, G (1939)	Male, 26	Chondrosarcoma of left innominate bone	Recovery	Alive and well 6½ years later
Gordon-Taylor, G (1942)	Female, 25	Moderately cellular spindle cell sarcoma of ilium Myxomatous degeneration	Recovery	Palliative operation Huge local recurrence—death 4 months later
Gordon-Taylor, G (1943)	Male, 45	Fibrosarcoma arising below inguinal ligament, ulcerated	Death	Fatal pulmonary embolism 11th day
Gordon-Taylor, G (1942)	Male, 43	Recurrent spindle-celled sarcoma of Scarpa's triangle	Recovery	Died of rapidly-growing secondaries 3 months later
Gordon-Taylor, G (1943)	Male, 40	Cellular spindle-cell sarcoma of muscles of left iliac fossa	Death within a few hours	
Gordon-Taylor, G (1943)	Male, 55	Myxochondrosarcoma of neck and trochanteric region of femur	Recovery	Local and general recurrence 1 year later Death 18 months after amputation
Gordon-Taylor, G (1944)	Female, 60	Spindle cell sarcoma of adductor region probably starting in fascial sheath	Recovery	Death from pulmonary metastases 4 months later

Table I—DETAILS OF INTERINNOMINO-ABDOMINAL AMPUTATION RECORDED IN LITERATURE OR KNOWN TO AUTHORS SINCE 1935 (73 IN NUMBER)—*continued*

SURGEON	SEX AND AGE OF PATIENT	DISEASE	RESULT OF OPERATION	REMARKS
Gordon-Taylor, G (1944)	Female, (7 months pregnant) 23	Myxochondrosarcoma	Recovery	Alive and free from recurrence 12 months after
Gordon-Taylor, G (1945)	Male	Infiltrating chondroma of pubic bone involving acetabulum	Recovery	Alive and free from recurrence 4 months later
Gordon-Taylor, G (1945)	Female	Fibrosarcoma of gluteal muscles—probably starting in fascial sheath	Recovery	Free from recurrence 3 months later
Harns, C W, and Laird, R C (1939)	Male, 48	Secondarily infected tuberculosis of hip	Recovery	Personal communication Alive and well, October, 1945, walking on tilting-table prosthesis
Harris, R, Toronto (1937)	Female, 37	Osteolytic sarcoma of upper end of femur	Recovery	Died of pulmonary metastases, 1939
Harris, R, Toronto (1941)	Male, 51	Fibrosarcoma Metastases in groin	Recovery	Died, 1943
Hume, Basil, St Bart's (1944)	Male, 49	Myxochondrosarcoma of pelvis	Recovery	Free from recurrence 8 months after amputation
Hume, Basil, St Bart's	Female, 37	Fibrosarcoma Recurrent tumour of adductor region and attached to ischiopubic ramus	Recovery	Free from recurrence 6 months after amputation
Hume, Basil, St Bart's (1945)		Details not available	Recovery	
Irwin, Gordon, Newcastle-on-Tyne (1942)	Male, 20	Fibrosarcoma of ilium, 19 cm × 12 cm	Recovery	Recurrent tumour when amputation done Alive and well more than 3 years after
Irwin, Gordon (1942)	Male, 29	Chondrosarcoma of ilium	Recovery	Recurrence and death 2 years later
Judin, S S, of Moscow 2 additional cases to that recorded in <i>Surg Gynec Obstet</i>		—	2 recoveries	Personal communication
Keating, Claud, Surgeon Commander (1944)	Male	Air-raid injury	Death 72 hours after	Quoted at one of Inter-allied Conferences, Roy Soc Med, London
King, Don, and Steelquist, J, of Stanford Univ, San Francisco (1940)	Male, 45	Osteogenic sarcoma	Recovery	Death 6 months later from pulmonary metastases <i>J Bone Jt Surg</i> , 1943, 25, 351
King, Don, and Steelquist, J (1940)	Male	Fibro-spindle-cell sarcoma of ilium under glutei	Recovery	Death 6 months later from pulmonary metastases
King, Don, and Steelquist, J (1942)	Male, 51	Osteolytic osteogenic sarcoma	Recovery	No sign of recurrence at 10 months after amputation
King, Don, and Steelquist, J (1942)	Female, 33	Huge tumour mass in iliac and trochanteric region Ilium eroded	Recovery	No after-history
King, Don, and Steelquist, J (1942)	Female, 50	Chondromyxosarcoma Rapidly growing tumour	Recovery	Whole length of thigh involved Well 6 months later
King, Don, and Steelquist, J (1942)	Male, 24	Destructive lesion of intertrochanteric area Recurrent tumour	Death	A palliative operation on desperately ill patient with gas-bacillus infection
Lenche, R, and Stulz, E (1936)	Male, 33	Chondromyxosarcoma of left thigh, with extension to pelvis	Recovery	Late history unknown <i>Pr med</i> , 1936, 44, 65
Lenche, R, and Stulz, E (1938)	Male, 29	Ewing's sarcoma of left femur—pathological fracture	Recovery	Late history unknown <i>Mém Acad Chir</i> , 1938, 64, 31
Leighton, W E, St Louis (1935)	Male, 24	Osteochondroma of wing of right ilium	Recovery	Well 6 years later <i>Arch Surg</i> , 1942, 45, 913
Leighton, W E (1939)	Female, 44	Chondrosarcoma of brim of pelvis	Recovery	Death 2 months later from pulmonary metastases
Leighton, W E (1941)	Male, 47	Osteogenic sarcoma of left ischium involving acetabulum	Recovery	Well 9 months after amputation
McCaw, New Zealand	?	Tuberculosis	Recovery	Amputation through thigh, followed by hindquarter Personal communication
MacCormack, St James's Hospital, Balham, London	?	Sarcoma	Recovery	Personal communication
MacCormack	?	Sarcoma	Death	Personal communication

Table I—DETAILS OF INTERINNO-MINO-ABDOMINAL AMPUTATION RECORDED IN LITERATURE OR KNOWN TO AUTHORS SINCE 1935 (73 IN NUMBER)—continued

SURGEON	SEX AND AGE OF PATIENT	DISEASE	RESULT OF OPERATION	REMARKS
Messent, P S, Adelaide (1936)	Female, 48	Myxosarcoma of innominate bone	Recovery	Death 2 months later from broncho-pneumonia (?)
Morton, John J, Rochester, N Y (1940)	Female, 51	Osteogenic sarcoma, chondro-type	Recovery	Death from recurrence 13 months later <i>Ann Surg</i> , 1942, 115, 628
Morton, J J (1941)	Male, 54	Probably a myxochondrosarcoma of upper end of femur	Recovery	Rapid recurrence Death 20 months later from widespread secondaries
Morton, J J (1940)	Female, 42	Metastases from carcinoma of thyroid	Recovery	No evidence of recurrence at 17 months
Morton, J J (1940)	Male, 55	Chronic infective arthritis of hip frequent operations	Recovery	Well at 15 months and working in minor capacity
Ogilvie, W H, Guy's (1937)	Female, middle aged	Spindle celled sarcoma of muscle	Recovery	Death from recurrence a few months later <i>Trans med Soc Lond</i> , 1937, 60, 139
Padovani, P (1939)	Male, 18	Enormous tumour of right pelvis	Recovery	<i>Mém Acad Chir</i> , 1939, 65, 361
Pascallis, G	Male, 44	Osteosarcoma of pelvis	Death	<i>Progr mtd</i> , 1936, 64, 1481
Platt, Harry (1938)	Male, 28	Highly malignant chondrosarcoma	Recovery	Death from recurrence 8 months later
Platt, Harry (1938)	Male, 29	Osteogenic sarcoma (chondrosarcoma) ischium	Recovery	Recurrence and death 9 months from amputation
Platt, Harry (1938)	Male, 36	Chondrosarcoma of ilium	Recovery	No sign of recurrence nearly 8 years after amputation
Platt, Harry (1939)	Female, 30	Extraperiosteal sarcoma ilium (fibrosarcomatous type) Very large tumour	Recovery	No sign of recurrence at 7 years after amputation
Platt, Harry	Male, 53	Osteogenic sarcoma ascending pubic ramus Pelvis site of widespread Paget's disease	Recovery	Death from recurrence 3 months from amputation
Platt, Harry	Male, 41	Osteogenic sarcoma of pelvis	Death 11 days after operation	
Rapant, Vlad (1938) (Bruhn)	Male, 29	Recurrent osteolytic sarcoma of upper third of femur	Recovery	Rapid recurrence in ilium a month after Death <i>Chirurg</i> , 1938, 10, 804
Rapant, Vlad (1938)	Male, 14	Osteolytic sarcoma of femur	Recovery	After history unknown <i>Chirurg</i> , 1938, 10, 804
Ricard and Clavel (1938)	Male, 36	Malignant tumour upper end of femur	Death	<i>Lyon chir</i> , 1938, 35, 81
Seelig, S (1941)	Male, 20	Ewing's tumour arising from ilium	Recovery	Death about 2 months after amputation from recurrence <i>J Bone Jt Surg</i> , 1941, 23, 929
Shvarts, Y E (1938)	—	Periosteal sarcoma of left hip	Death	Re-activation of old pulmonary tuberculosis and epitecemia from local necrosis <i>Vestnik Khir</i> , 1938, 55, 57
Turner, G Grey (1938)	Female, 31	Recurrent chondroma originating in left ilium	Recovery	Local recurrence 4 years later Well 7 years after amputation
Turner, G Grey (1941)	Male, 49	Recurrent chondrosarcoma of antero-internal aspect of ilium (left)	Recovery	Patient had Paget's disease of lower spine and pelvis Recurrence Death 2½ years after amputation
Turner, G Grey (1944)	Female, 38	Extensive tuberculosis of hip-joint Anaemia and lardaceous disease	Recovery	1 year later making progress, but not quite healed
Warwick, W Turner (1945), Middlesex	Male	Osteolytic sarcoma	Recovery	
Whittaker, A H, and Sobin, D J (1941)	Male, 40	Spindle cell sarcoma of right thigh	Recovery	Death 6 months later of intra-cranial metastases <i>Ann Surg</i> , 1942, 115, 435
White, R G, of S Rhodesia (1944)	Male, 55	Large fungating melanoma of leg 9 in × 6 in Large glands in groin and iliac fossa	Death	Private communication
Wiles, Philip		Infective osteomyelitis of innominate bone with multiple sinuses	Death	Private communication

12 Plenty of firm elastoplast to support the wound

13 Binder to hold dressing on top, when it is necessary to re-pack

14 Sulphamezathine, 4 g statim, and 2 g four-hourly up to 40 g, may sometimes be considered wise

To our anæsthetist colleagues who have devoted their time, experience and skill to aid us we are under a deep debt of obligation. Our former colleague, Raymond Apperly, has pride of place in the number of hindquarter amputations (5) at which he has assisted, A E W Idris has officiated on four occasions, H P Crampton and Brian Sellick each three times, F W Roberts and A J H Hewer, each twice, and Hugh A Richards, of King's College, and R J Clausen, M C, of Charing Cross Hospital, at one ablation each

To our ward sisters our gratitude is immense, and if the name of Miss Exley is specially mentioned, the number of cases that she has nursed far exceeds that of any of our other nursing colleagues, and much of the after-treatment now in vogue for these patients has emanated from her experience. The Theatre Sister-Superintendent at "Middlesex", Miss Thomas, G C, has actively presided over nearly every amputation, and has proved a great surgical ally

### SUMMARY

1 The operative recovery-rate in 21 personal cases of hindquarter amputation (G G-T) has been 71 per cent

2 The operative recovery-rate of the last 10 hindquarter amputations performed by the two authors has been 80 per cent

3 The operative recovery-rate in 80 cases collected from the literature or by private communication has been 82 per cent—a remarkable improvement on the 40 per cent recorded for all cases operated on up to 1935

4 Final prognosis is most favourable in the infiltrating chondroma or chondrosarcoma, some cases being free from recurrence nearly 10 years after amputation

5 Several other tumours of differing histology have remained well for considerable periods, e.g., Girdlestone's osteogenic sarcoma of the ilium (5 years), Harry Platt's extraperiosteal sarcoma of the ilium (7 years), Gordon-Taylor's spindle-cell sarcoma of muscles of the upper thigh (11 years) and his diffuse osteoclastoma of the innominate bone

(17 years), and Davison's carcinoma of the skin of the groin (7 years)

Our best thanks are due to surgical friends and colleagues who have honoured us by transferring cases to our care where this form of amputation has seemed a probable line of treatment or who have kept us informed of their own operations. We are also deeply indebted to Professor Brian Windeyer who has given us of his wide experience and learning, and to Dr R W Scarff, of the Bland-Sutton Institute, our debt is immense. Our old dresser, R Graham White, of Rhodesia, has spared no pains to keep us informed of any additions to the literature of the subject

Those who have been wholly immersed in the surgery of the recent war will have little difficulty in recognizing the beautiful artistic work of Mrs C G True and of Mr P G Hennell. We are also under a deep obligation to our friend and colleague, Dr C P Smith, who is responsible for Fig 87

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# A DISCUSSION ON THE TREATMENT OF INJURIES TO THE HAND

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In this mechanical age the manual worker may, from the very nature of his work, injure his hands. With increasing mechanization these injuries will become more numerous, and many of these disabled patients will become subjects for compensation. Accidents to the hands head the list of industrial injuries, with their consequent loss of man-hours. This paper attempts to discuss severe injuries of the kind which ultimately need some degree of reconstruction.

It is a fair criticism that of all injuries those to the hands are probably the worst treated, and at any reconstructive surgical Out-patients' Department numerous examples of the badly-treated injured hand can be seen. Many justifiable excuses can be advanced for this situation when compared with other branches of surgery. The surgical treatment of an injured hand is a highly specialized job, involving the use of a specialized technique and tools. The general surgeon, besides being ill-equipped in every way to deal with such cases, cannot afford the time to carry out a series of operations which are tedious, lengthy, and which only too often finally disappoint both him and his patient. At present all hand injuries cannot be absorbed into specialized centres, but a clear conception of the principles of treatment of the badly injured hand would do much to improve this neglected branch of surgery.

## GENERAL CONSIDERATIONS

It is a mistake to believe that the reconstruction of a hand takes place in the operating theatre. First, as accurate a diagnosis as is possible is made from an examination of the hand, which should include radiographs. Accurate note-taking, even if brief, is essential. In a difficult hand, a complete examination with records may take an hour or more. Only by attention to detail at the beginning of treatment can the surgeon hope to arrive at a successful conclusion. The age of the patient and his work and its significance should be considered. The position of the fingers will depend on the functional diagnosis. Therefore the treatment will differ for the artisan, clerk, and mannequin. For example, the semi-flexed first interphalangeal joint of the fifth finger may encumber the artisan, be satisfactory for a clerk, yet unsightly for the mannequin. The artisan requires primarily a fully functioning hand, the cosmetic appearance of which is of secondary importance, but the mannequin requires a hand in which the cosmetic appearance may be more important than the functional result. It will mean that as long as the hands are part of the show piece, treatment will be directed to that end. If destruction of the joints of the fingers has occurred, for instance, ankylosis in full extension may be indicated. The clerk requires treatment that takes into consideration both the functional and cosmetic result. The patients' hobbies and athletic tendencies must be given consideration. Whilst the reconstructed hand

may satisfy the patient in relation to his daily work, the fact that he is unable to continue, for example, his golf, may seriously influence his opinion of the result. The history must make a careful note of the many aspects of the patient's social life which will modify the planned treatment. What the patient actually complains of, in relation to his daily work, is probably the most significant fact gleaned from the whole mass of information. Failure to pay attention to this simple fact will inevitably disappoint the patient in his final result. Frequently, an accurate prognosis of the final functional result cannot be given until the surgical reconstruction of a hand is approaching finality. This fact must be made clear to a patient who is expected to undergo a series of tedious operations. Concomitant infections, such as rheumatoid arthritis, will considerably modify any attempted repair. A definite plan of treatment must be evolved. Even if allowances are made for the vast differences of opinion which quite justifiably exist, without a predetermined plan little chance of success is possible.

The operative repair of hand lesions involves a detailed knowledge of normal anatomy. It is not enough to rely on the dim memory of anatomy learnt many years before. The intimate association of nerves, tendons and their sheaths, blood-vessels, and fascial planes and spaces renders many of them liable to injury at the same time. Frequently such post-traumatic hands are seen with the palm concealed in a mass of scar tissue. If the normal anatomy is not known it is quite impossible to recognize the real nature of the lesion with even the least chance of affecting the best repair. If, for instance, the anatomy of the metacarpophalangeal and interphalangeal joints and the extensor expansions was well understood, advocates of prolonged immobilization for hand injuries would considerably modify their views.

It is necessary to complete the skin repair first, before attempting reconstruction of the deeper structures. It is impossible to operate through dense scar where muscles, tendons, and nerves are infiltrated with resolving fibrosis. Even when resolution is complete, hands involved in deep cicatrix frequently show a deficient nutrition characterized by the shiny colour and atrophic texture of the skin, and this will not improve until all scar is resected and a good skin covering supplied. The scar is usually far more extensive than clinical examination reveals. The rate of recovery varies, and whilst in some it may occur in six to eight weeks, in others it may take as many months. There are no rules for the rate of resolution of fibrous tissue in these cases and each must be treated on its merits.

Joints must be mobilized before tendon repair is undertaken. It is pointless to undertake extensive tendon grafting and suture if the joints are stiff or involved in scar. Again, an arthroplasty must not

# TREATMENT OF HAND INJURIES

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be combined with a tendon repair of the same joint because the post-operative treatment of each is completely diverse

Nerve repair must be carried out before tendon repair is contemplated. A successful tendon suture to an anaesthetic finger loses point because the individual will not use it. An anaesthetic thumb or finger gets in the way and suffers repeated minor damage unknown to the patient. It undergoes atrophy involving all structures. The nails become brittle, the skin dry and smooth, and the joints stiff. Accurate nerve suture offers a good prognosis for digital nerves, and this is particularly true if immediate suture is carried out should a nerve be accidentally divided during a dissection on the hand.

Post-operative splinting is frequently necessary and as a general rule volar splints for dorsal lesions and dorsal splints for volar lesions should be used. All joints should be immobilized in the position of physiological rest unless the operative procedure or the lesion demands otherwise. The fingers at rest assume a position midway between the limits of flexion and extension of each joint, and the thumb is partially opposed with its joints similarly semi-flexed. The wrist-joint is also dorsiflexed to about 20°, with 10° of ulnar deviation. The ability of the thumb to oppose the tip of the index or middle finger cannot be over-emphasized, and even though only a minimum of motion of the fingers and thumb is obtained, the patient will have immediately a useful hand for gross purposes.

and interossei on the metacarpophalangeal joints, for example, permits the long extensor muscles to extend the distal two joints of the finger. Coordination between prime movers, antagonists, and synergists is soon lost, and treatment should be aimed at the re-education of these movements. The assembly of small mechanical apparatus, such as Meccano, is excellent. The exercises involved begin with the simple models and progress to the



FIG 94—Photograph to illustrate the type of splint used at this Unit to increase range of movement by prolonged traction, the traction being provided by elastic bands

Only that part of the hand which is involved in the operative procedure should be immobilized. There are many enthusiasts for Trueta's closed unpadded plaster for the treatment of hand injuries. Whilst the plaster cast has its place in war-time for the temporary treatment of some injuries, as far as fingers are concerned, prolonged immobilization is disastrous. Trueta's method applied to the fingers in burns, for instance, has not been a contribution to surgical progress. The commonest cause of a stiff hand in burns is prolonged immobilization, in traumatic lesions, sepsis. As soon as the clinical condition and dictates of the treatment of the wound permit, active movements should be begun if early restoration of function is to be obtained. The importance of physiotherapy, which includes short-wave and infra-red treatment, wax baths, and massage, cannot be over-estimated, but it must be emphasized that active movements will replace hours of passive treatment. Splints designed to increase range of movement by prolonged traction are useful adjuncts to treatment (Fig 94). Such splints, particularly if worn at nights, but in no way replacing active movements, will naturally assist in treatment. Coarse movements recover first, and it may be many months before fine co-ordinated movement is possible. Treatment should be aimed at the re-education of the fine movements. Movement is the result of co-ordination of the action of several muscles and tendons. Even a simple voluntary movement—for instance, clenching the fist—requires the contraction of the flexor group of muscles or the prime movers, and elongation of the extensor muscles or antagonists. The extensor group of muscles in this case are also synergists and fix the wrist-joint. The synergic or stabilizing action of the lumbricals more difficult, so that automatic, rhythmic, and repeated movements are carried out, entirely divorced from mental concentration. Whilst it is invaluable to re-educate and co-ordinate hand movements, it is also interesting, and the patient will tend to adhere to such a method of treatment. The intelligent co-operative patient will recover full function many weeks before the duller and more unco-operative type. The progress of a stiff hand is largely dependent on the patient himself. The short time which he can spend in a physio-therapy department should be directed to the type of treatment which he himself must undertake during the remainder of the day. It is here that industrial therapy can play such a vital part in this essential period of the regulated treatment. At this Unit a sub-branch of an aircraft component assembly shop was established, and every patient with a lesion involving the fingers was directed to this department twice during the day, each period lasting two hours. The exercises or jobs were graduated so that the successful accomplishment of an exercise provided the groundwork or training for the forthcoming more difficult exercise. These exercises were sufficiently easy to permit patients to carry on normal conversation while working, and therefore perform a series of co-ordinated, rhythmic, automatic finger movements subconsciously.

The common mistakes in the surgical treatment of hand lesions are —

- 1 Sepsis—Sepsis is still the commonest cause of stiff hands. Untreated and badly treated cases contribute to the large number of cases that require some degree of reconstruction. Extensive infections resolve by fibrosis leading to compression of blood-vessels, lymphatics, and nerves, with ensuing trophic

changes, ankylosis of joints, and contraction of muscles, while adhesions about the tendons or their destruction adds to the disability. At operation, in those cases in which tendon-sheaths have been involved, the synovial sheath is entirely obliterated and there is complete fibrous union between the tendon and its sheath throughout its extent. In the majority of cases the tendons are indistinguishable as tendons from the surrounding connective tissue. The most unfortunate sequelæ, however, is that produced in the lumbricals and interossei, which may be entirely destroyed. The clinical appearance in its worst form is the 'frozen' hand. Early diagnosis and drainage by correct incisions, combined with adequate chemotherapy, particularly penicillin, should banish these crippled hands from hospital wards.

2 Prolonged immobilization, frequently in faulty position, will cause unnecessary loss of finger movement. In addition to intra- and periarticular adhesions and wasting of intrinsic muscles, shortening takes place in tendons and the neurovascular bundle. If the immobilization is prolonged, that part of the articular surface not actually in contact with its opposing articular cartilage atrophies and finally disappears. The remaining articular cartilage gradually adapts itself intrinsically to the shape of the opposing surface. This process is accompanied by shortening of the joint capsule and collateral ligaments, successfully anchoring the joints in this position (Fig 95). It is quite impossible to restore



FIG 95—Diagram to illustrate the articular surfaces and collateral ligaments of a joint of the finger before and after prolonged immobilization

full function under these conditions, but active movements, as produced by industrial therapy, combined with intensive physiotherapy, will salvage what remnants of movement are possible.

3 Forcible manipulation of joints under general anaesthesia is absolutely contra-indicated. Whilst a full range of movement can be attained immediately, the final result is always worse. This is easily understood if the pathology and anatomy of these complex joints is understood. Forcible flexion of a metacarpophalangeal or interphalangeal joint will tear the collateral ligaments and cause rents in the capsule. Subsequent post-manipulative pain prevents early movement and the lesion heals by scar tissue and the joint will become even stiffer. Gradual increase in movement is only obtained by concentration on directed active movements and splints designed to apply sustained traction to maintain the favourable position gained. All other physiotherapeutic measures are only adjuncts to treatment.

4 Raw areas on the hands must not be allowed to heal by granulation but should be covered with skin as soon as possible. This is particularly true

where tendons are exposed. The fibrosis that accompanies the healing of raw areas by granulation involves the deeper structures to a greater or lesser degree. The scar will subsequently contract and will require a major procedure to correct. Infected granulation tissue will convert a superficial lesion into a deeper lesion which may involve tendons and joints. With adequate chemotherapy it is essential to convert open wounds into closed wounds by covering them with skin immediately. Only by such means can healing occur rapidly, and thus the damage caused be reduced.

5 Operative procedures on the hands must be carried out in a bloodless field secured with a pneumatic type of tourniquet. It is impossible to dissect among the closely packed tendons and nerves in a field swimming in blood. A clear demonstration of anatomical details and identification of each structure is a necessity, particularly if the operative field is involved in scar tissue. Prolonged ischaemia of a hand already suffering from deficient nutrition is obviously not desired, but the clarity of a bloodless field far outweighs the damage that can easily be inflicted whilst blindly dissecting in a palm, the field obscured by blood. On the other hand, it has been argued that the ischaemia produced by tourniquets will induce a generalized tissue reaction, as indicated by delayed healing and prolonged residual stiffness in a previously mobile hand. In this unit only the pneumatic type of tourniquet is used. Even when occlusion is maintained for as long as 2½ hours nerve lesions have not been observed. This degree of safety cannot be claimed for such tourniquets as the Esmarch type. The tourniquet should be released for 5–10 minutes every hour. Immediately on releasing the tourniquet, blood floods the wound. A period of reactive hyperaemia follows, which appears within a few seconds, and is presumably due to the products of tissue activity.

These vasodilator substances affect arterioles and capillaries alike. The degree of hyperaemia is greater and more lasting as the period of occlusion is prolonged. This period may last up to 20 minutes before haemostasis can be satisfactorily demonstrated. Firm pressure with warm packs will help to reduce capillary ooze. All bleeding points are secured, great care being taken not to nip nerves which pursue a path proximal to the arterial system. Finally, the raw area is swabbed with fibrin foam, and/or fibrinogen and prothrombin added to the oozing area. To secure satisfactory haemostasis may take as long as the actual constructive operation in question, but is just as important. Failure to secure perfect haemostasis following operations on the hands will destroy hours of perfect work.

Hæmatomata undergo resolution with replacement fibrosis involving the whole operative field. Tendons, nerves, blood-vessels, muscles, fascia, and skin become knitted together by scar. And weeks may elapse before function is restored. Drainage for 24–48 hours, combined with a pressure dressing to control capillary oozing without ischaemia, is essential. Much practice is needed before the correct amount of pressure is known. Twenty-four hours after operation the bandages should be loosened and re-applied at the proper degree of

pressure to accommodate the post-operative swelling which takes place. Freshly operated hands should always be elevated whilst in bed, and in a sling when ambulatory. Prolonged ischaemia will lead to necrosis and gangrene of the terminal parts of the fingers, with disastrous results. The finger tips should always be left exposed so that the circulation can be watched. Loss of a finger tip through tight bandaging is a disaster that is not easy to explain to the patient.

6 In many cases attempts at repair are carried out under unsuitable conditions, using unsuitable instruments and suture material, and good results are hoped for rather than anticipated. The surgery of the hand is a specialized job involving the use of a specialized technique and adequate facilities for post-operative treatment. Too many hands are referred to special centres only after an attempt at repair or reconstruction has already failed, thus increasing the reconstructive surgeon's difficulties and decreasing the possibility of obtaining the better result. The greatest care possible should be taken when it is necessary to handle tissues. To achieve this end special light-weight forceps of the McIndoe type are used. Fine dural hooks are used as retractors. Suture materials are of the finest black silk on atraumatic sharp needles. The mosquito pattern artery forceps, which pick up only the bleeding point, are used. Sharp instruments are maintained with a keen edge. Practically all operations are conducted with the surgeon seated, so that he is adequately relaxed. Tremor is eliminated by bracing the fingers as a fulcrum and resting the forearms on something solid. With a bloodless

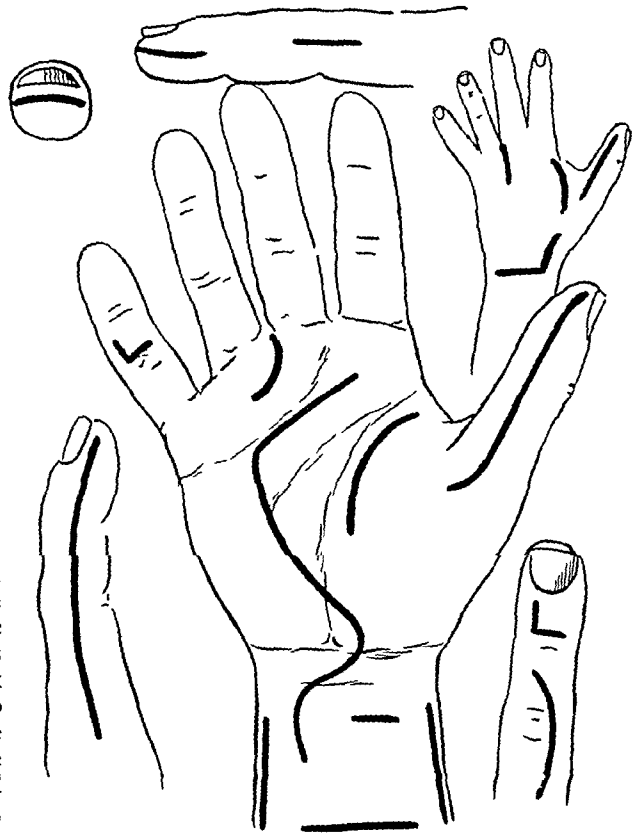


FIG 96—Incisions for surgery of the hand (After Bunnell)

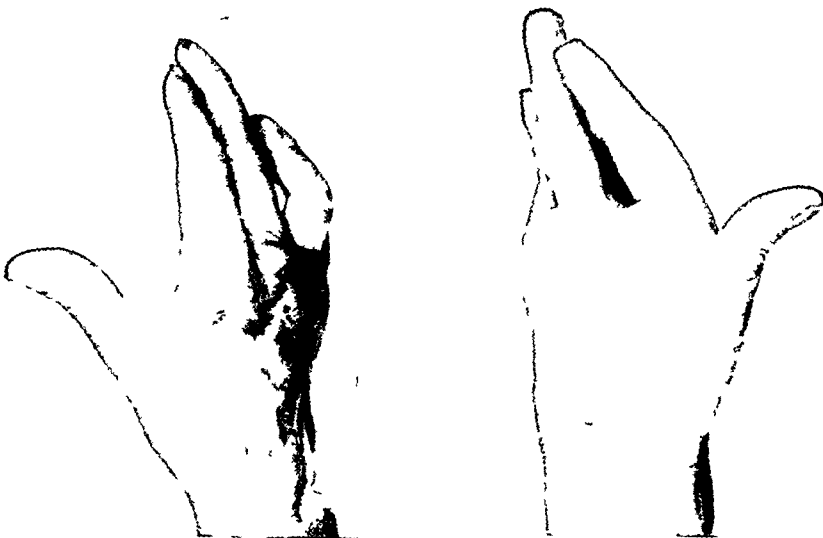


FIG 97—These photographs illustrate the rotation deformity of the fingers following partial resection of the metacarpal bone of the middle finger

field, trauma produced by repeated sponging is eliminated. Only by great delicacy in handling the tissues can the ensuing tissue reaction be reduced to a minimum. It is surprising that even to-day incisions are practised that can only lead to flexion contractures. No incision in the palm of the hand

should ever be made longitudinally across a joint crease. These longitudinal incisions may heal with contraction of the scar, preventing full extension of the involved joints. The worst examples are to be seen following operations for acute infections of the hand or for Dupuytren's contracture where these

incisions have been used. They are inexcusable. Koch and Kanavel probably did most work to establish the use of incisions that do least harm. Bunnell has modified these incisions and the diagram (Fig 96) indicates those he recommends. It is noticeable that these incisions take into consideration the normal crease of the hand and the exposure of the underlying anatomical structures, and are almost invisible in time.

7 Attempts at tendon reconstruction through scar, or with involved joints stiff or ankylosed, is doomed to failure. Multiple injuries to a digit involving nerves, tendons, joints, and skin is an indication for amputation, not reconstruction. A single mutilated digit in a working man is best removed. A residual disability with lack of full function inevitably makes such a member a nuisance to him. The functional result of the hand is more important to him than the cosmetic appearance.

Generally speaking, amputations of the index and fifth fingers should not leave a short stump, because it may get in the way. Cosmetically, an oblique removal of the corresponding metacarpal bone is good, because a single missing finger is rarely noticed. Amputations of the middle or ring finger, involving the metacarpal head, must be accompanied by resection of the corresponding metacarpal bone with reconstruction of the transverse carpal ligament. Failure to remove the metacarpal bone and collapse the hand will cause a rotation deformity of the adjoining fingers. Lack of reconstruction of the transverse metacarpal ligament will accentuate this deformity, with subsequent marked loss in function (Fig 97).

I am greatly indebted to my teacher, Mr A H McIndoe, C B E, for so much help, encouragement, and assistance in the preparation of this paper.

## DISLOCATION OF THE INFERIOR RADIO-ULNAR JOINT

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UNCOMPLICATED acute dislocations in the region of the wrist are infrequent in comparison to the well-known fractures. This paper is limited to a presentation of four cases of dislocation involving the inferior radio-ulnar joint, one case of a dislocation at both ends of the radius, and one case of dislocation of the scaphoid. Radiocarpal dislocations and the other dislocations of and around the carpal bones are omitted.

### ANTERIOR AND POSTERIOR DISLOCATIONS OF THE INFERIOR RADIO-ULNAR JOINT

The dislocation may be described in terms of the movement of the head of the ulna in relation to the lower end of the radius, an anterior or a posterior dislocation being a displacement of the ulna in front of or behind the radius respectively. Of the cases reported here, three were anterior dislocations and one was a posterior. This nomenclature is in common usage and is retained, although open to criticism. It may be more correct, however, to describe the displacement in terms of the mobile lower end of the radius in relation to the fixed ulna.

#### CASE REPORTS

**HISTORY**—One case was a young woman and three were middle-aged men. In all there was a history of a fall on the hand, associated with a considerable rotation of the rest of the limb once the hand had become fixed on the ground. Forcible pronation caused the posterior displacement and supination the anterior.

**CLINICAL FEATURES**—All the injuries were of recent origin and the patients attended for treatment within twenty-four hours of the accident. Pain was outstanding and seemed to be of greater severity than in a Colles's

fracture. There was almost complete loss of any movements at the wrist. The visible deformity in the anterior dislocations was very marked, a distinct dimple being present in place of the normal prominence of the head of the ulna and the breadth of the wrist being narrowed. The head of the ulna was not visible, but was palpable in front of the radius, deep to the flexor tendons. In the posterior dislocation the head of the ulna was unduly prominent and lying on the back of the radius.

**X-RAY EXAMINATION** (Figs 98-100)—The X-ray appearances were less prominent than the clinical features, and, on a hurried glance, what was in reality a true lateral view of the dislocation was liable to be mistaken for a normal oblique view. After the clinical examination, however, the features were quite obvious. The radius and ulna were in wrong alignment, the lower end of the ulna was either in front of, or behind, the radius, and the articular notch for the ulna on the radius was empty. Three of the cases showed no fracture and one showed a crack in the radial styloid without any displacement, which was neither the cause nor the effect of the dislocation.

**TREATMENT**—The same treatment was applied to all cases. Under general anaesthesia, manipulation was carried out by a combination of rotation and direct pressure over the head of the ulna, a distinct click indicating successful reduction. A dramatic relief from pain followed. The wrist was kept immobilized in plaster for three to four weeks, and by the end of another week full movements were restored, no disability ensuing.

#### DISCUSSION

According to Gibson (1925), on theoretical grounds, the mechanism of the dislocation might be (a) A force applied in an abnormal direction so as to separate the bones or to push one past the other tangentially, or (b) A force applied in a normal direction but excessive in amount. Judging by the

personal cases, the essential feature of the mechanism seems to be a sudden excessive rotation combined with a longitudinal force. The inevitable result is tearing of the radio-ulnar ligaments and the triangular fibrocartilage, an alternative to the latter is an avulsion of the ulnar styloid. The pronator quadratus remains intact.

Such isolated and uncomplicated dislocations of the inferior radio-ulnar joint are rare, and Gibson (1925) remarked that few surgeons had seen more

repair with fascia. Several of the chronic lesions are preventable by correct treatment of an original injury.



FIG 98—Anterior dislocation of inferior radio-ulnar joint, well marked dimple in skin overlying head of ulna

than one case. Cotton and Brickley (1912) knew of 27 previous cases and Cox (1942) stated that Vergoz and Choussat had collected 68 cases by 1937. A remarkable feature is that many of these were not diagnosed at first, being recognized several weeks later, by which time open operation was necessary. It is obviously desirable to diagnose the injury at once, as treatment by manipulation is easy and the subsequent result is excellent.

Distinct from this type of injury, there are other causes of the dislocation which are relatively common. As regards acute injuries, many cases of Colles's fracture and fractures of the shaft of the radius with overriding and/or angulation are associated with subluxation or dislocation of the inferior radio-ulnar joint. This type generally responds to the correct treatment of the fracture.

There is also a type of permanent or recurrent subluxation or dislocation, those cases with posterior displacement of the ulna being loosely classified as Madelung's deformity. The possible causes include a congenital deformity, an old injury of the triangular fibro-cartilage or radio-ulnar ligaments leading to laxity of the joint, an untreated acute dislocation, malunited fractures causing axial deviation of the radius and ulna, relative shortening of the radius due to an old epiphyseal injury, a previous fracture, too free excision of the upper end for a fractured head of radius, previous rickets, a destructive lesion such as osteomyelitis, tumours or bone dystrophies, chronic arthritis, enlargement of the head of the ulna.

In these chronic cases the treatment varies widely, depending on the original cause and the degree of disability. In the selected case operation may consist of excision of the lower end of the ulna, osteotomy and/or bone-grafting of the radius, or



FIG 99—Anterior dislocation of inferior radio-ulnar joint

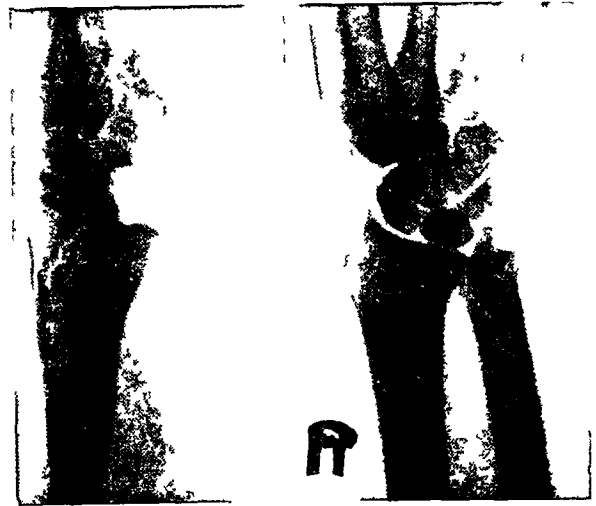


FIG 100—Anterior dislocation of inferior radio-ulnar joint. Also crack in lower end of radius, not part of the mechanism of the dislocation.

## VERTICAL DISLOCATION OF THE INFERIOR RADIO-ULNAR JOINT, ASSOCIATED WITH POSTERIOR DISLOCATION AND FRACTURE OF THE UPPER END OF THE RADIUS

### CASE REPORT

**HISTORY**—A young man was at work in a coal-mine, and, while the elbow was flexed at right angles, the left forearm became jammed between a moving and a stationary hutch, so that a very severe force was applied longitudinally to it.

**CLINICAL FEATURES**—The patient obviously had a severe injury, causing much pain, but there was no wound in the skin. There was extreme swelling of the elbow, forearm, and wrist, movements were absent, and the hand was displaced to the radial side. The ulnar styloid was palpable distal to the radial styloid.

**X-RAY EXAMINATION (Fig 101)**—There was a dislocation of the inferior radio-ulnar joint, with marked proximal displacement of the radius, the ulna protruded distal to the radius, and was displaced posteriorly and

attempts at manipulation both then and also three days later

One week after the accident an open operation was performed through a vertical incision on the dorsum of

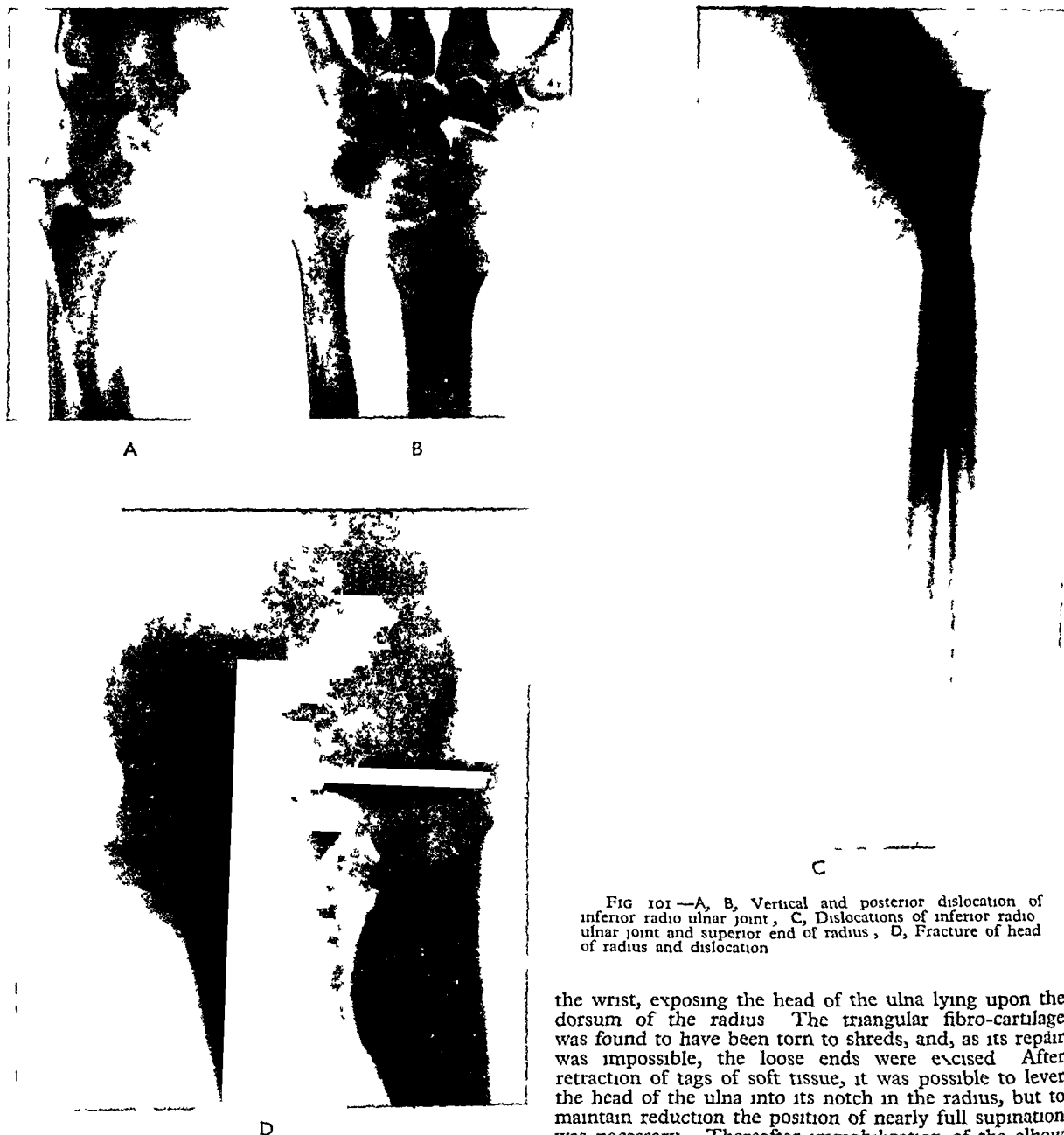


FIG 101—A, B, Vertical and posterior dislocation of inferior radio ulnar joint, C, Dislocations of inferior radio ulnar joint and superior end of radius, D, Fracture of head of radius and dislocation

medially. The upper end of the radius was dislocated posteriorly from the elbow-joint and there was a fracture of the head of the radius, a small fragment being displaced towards the medial side.

**TREATMENT**—Under general anaesthesia, manipulation was carried out three hours after the accident. By applying strong traction and direct pressure over the upper end of the radius, the proximal dislocation was easily reduced. The vertical displacement of the inferior radio-ulnar joint was thereupon corrected, but the head of the ulna remained displaced posteriorly, defying

the wrist, exposing the head of the ulna lying upon the dorsum of the radius. The triangular fibro-cartilage was found to have been torn to shreds, and, as its repair was impossible, the loose ends were excised. After retraction of tags of soft tissue, it was possible to lever the head of the ulna into its notch in the radius, but to maintain reduction the position of nearly full supination was necessary. Thereafter immobilization of the elbow and wrist was maintained for six weeks, and was followed by physiotherapy.

In assessing the final result one year later, flexion and extension of the wrist and flexion of the elbow were complete, and extension of the elbow was to  $150^\circ$ . The forearm was in the mid position of pronation and supination, but no more than  $5^\circ$  of movement were possible. Further operative treatment to improve pronation and supination was not contemplated, as excision of either the head of the radius or the lower end of the ulna alone would not be sufficient, whereas excision of both would tend to instability of the forearm.

## DISCUSSION

A complex injury of this nature has not apparently been reported previously. Gibson (1925), in discussing inferior radio-ulnar dislocations, stated that forcible distraction of the bones was probably of theoretical interest only, and he was unable to find a reference. In the case reported, the longitudinal force applied to the forearm probably caused first a fracture and then a dislocation of the upper end of the radius. Only then was it possible for the vertical dislocation to take place at the inferior radio-ulnar joint. In addition to the features already mentioned, there was a disruption of the superior radio-ulnar joint, and the interosseous membrane was bound to have been severely torn. In view of the multiplicity of the injuries, the final result could be considered quite satisfactory.

DISLOCATION OF THE SCAPHOID  
CASE REPORT

**HISTORY**—A young man employed in building construction found himself threatened by a heavy metal girder which was being lifted by a crane and was swinging out of control. To save himself, he pushed it away forcibly with the outstretched left hand and at once experienced severe pain in the wrist.

**CLINICAL FEATURES**—Swelling and tenderness were marked over the scaphoid, but there was no particularly distinctive feature. Considerable disability was present.

**X-RAY EXAMINATION (Fig 102)**—No fracture was



FIG 102—Dislocation of scaphoid with anterior displacement of proximal end

present. The proximal end of the scaphoid was completely dislocated from the radius and lunate and was directed anteriorly, having been tilted through about 80°. The distal end of the scaphoid remained in contact with the trapezium. The lunate appeared to be slightly displaced towards the ulnar side.

**TREATMENT**—Under general anaesthesia, manipulation was performed twenty-four hours after the accident.

By means of strong traction on the thumb and index finger and direct pressure on the proximal end of the scaphoid, reduction of the deformity was accompanied by a distinct snap. X-ray examination, however, showed that the scaphoid and lunate were not perfectly approximated, so that a second manipulation was required three days later, complete reduction then being obtained. The wrist was immobilized in plaster for six weeks, but recovery of function was slow thereafter. Ultimately, after four months, dorsiflexion and palmar flexion of the wrist were restored to three-quarters of the normal range, movement being quite painless. The grip was strong and thumb movements were complete.

## DISCUSSION

This is a very rare carpal injury and few cases have been reported. Buzby (1934) recorded a case where the scaphoid was rotated to the lateral side and the proximal end was tilted anteriorly, manipulative reduction was successful. In the case reported by Walker (1943) the proximal end of the scaphoid was completely tilted laterally, whereas in the case treated by Watson-Jones (1944) the proximal end was lying behind the radius and the tubercle was prominent in the palm, operative reduction was necessary in both. There is thus no uniformity in the direction in which the dislocation may take place. In an anterior dislocation the mechanism appears to be a forcible dorsiflexion of the wrist combined with an excessive rotatory strain, in the posterior dislocation acute hyperflexion of the wrist may be the cause.

## SUMMARY

1 Four cases are reported of dislocation of the inferior radio-ulnar joint, three with anterior displacement of the ulna and one with posterior displacement. Manipulative reduction was successful. Other causes of such dislocations are reviewed.

2 A complex forearm injury is described, with dislocation of the inferior radio-ulnar joint and of the upper end of the radius, along with a fracture of the latter. Operative reduction was necessary for the wrist lesion.

3 A dislocation of the scaphoid was successfully treated by manipulative reduction.

We wish to thank Dr R McWhirter and Dr J G Kininmonth for the radiological examinations.

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## A CASE OF ACUTE ANAEROBIC STREPTOCOCCAL INFECTION OF THE NECK OF DENTAL ORIGIN

BY MAJOR C GEOFFREY BOOTHROYD, A D CORPS, MEF  
AND LIEUT -COL CAMERON MACLEOD, RAMC, MEF

THE incidence of acute spreading cellulitis of the neck, of dental origin, is fortunately uncommon. The following case is deemed worthy of record for two reasons—first, to illustrate the speed with which a streptococcal infection may progress to a fatal termination when once the process has spread beyond the barrier of the mylohyoid muscles, and, secondly, because at the autopsy the authors were fortunate in obtaining specimens and evidence indicative of the course of events.

### CASE REPORT

**HISTORY**—Some eight months prior to the onset of his final illness, the patient, a well-developed male of 34, had complained of thermal sensitivity in  $\overline{7}$  region. A dressing was inserted in the tooth and this symptom subsided, until a "slight toothache" occurred three days prior to his admission. The following day, pain became acute in the region of the left angle of the mandible and a pyrexia developed. Thereafter his condition became progressively worse, and treatment was supplemented by the administration of M & B 693, until he was admitted to hospital at midday on Feb 22, 1945.

**ON ADMISSION**—The clinical dental state was fair  $\overline{568}$  were missing from the left mandible. The crown of  $\overline{7}$  was abraded to within one millimetre of the gingival margins, the coronal surface being covered with temporary cement. The tooth did not react to thermal tests, and was only mildly tender to percussion. There was no inflammation of the soft tissues in its immediate proximity. Trismus was present, but was not sufficiently marked to interfere with intra-oral examination. The floor of the mouth was indurated, and the tongue could not be protruded. The clinical dental picture remained unchanged throughout.

The general condition was very poor. Temperature  $102^{\circ}$ , pulse 110 and irregular, respirations 24. Colour of face ashen-grey. Dysphagia was extreme, and an irritable cough persisted, with expectoration of much frothy mucus. There was a generalized brawny swelling of the neck, extending from sternomastoid to sternomastoid, and from mandible to manubrium sterni, with some oedema superficial to the latter. The larynx and trachea appeared to be displaced forward. Pitting oedema of the skin was present in the left anterior triangle of the neck, but no definite fluctuation could be detected. X-ray examination revealed an unerupted third molar lying mesially, with areas of apical osteitis in relation to the mesial and distal roots of  $\overline{7}$  and the distal root of  $\overline{8}$ .

**TREATMENT**—Parenteral penicillin, initial dose of 20,000 units immediately on admission, followed by 15,000 units three-hourly. Antiphlogistine to neck. Hot mouthwashes (sodu sulph in flavine).

**Progress**—Temperature fluctuated between  $102^{\circ}$  and  $103.4^{\circ}$ , with a pulse-rate rising to a maximum of 128 in the early hours of Feb 23. Respirations varied between 22 and 23. The patient passed a poor night, expectorating mucopus in quantity. Blood-count, WBC 15,800 per c mm., polymorphs 90 per cent, lymphocytes 8 per cent, mononuclears 2 per cent.

The general condition continued to deteriorate during the day, and the dysphagia became complete. Radiographs of the neck taken at this stage disclosed an

ill-defined soft-tissue swelling extending as far down as the manubrium sterni, and lateral views showed a definite increase in the post-cricoid space. No abnormality was shown in the lungs. Intramuscular penicillin was continued with no apparent response. Culture taken from the  $\overline{8}$  region showed a light growth of hæmolytic streptococci, and a moderate growth of *Staph aureus*, the combined penicillin sensitivity factor being 0.4.

On examination of the neck in the afternoon, a doubtful area of fluctuation was detected in the left anterior triangle, in the area where oedema had been previously noted. The opinion of the medical specialist having been previously obtained regarding the heart, and in consultation with the anesthetist, operation was decided upon, if not to find pus, to relieve tension under the deep cervical fascia, and thus relieve the urgent dysphagia.

Hyoscine (gr 1/150) and avertin were administered at 18.30 hr.

**OPERATION**, 19.00 hr, Feb 23 (Lt-Col Cameron MacLeod)—Endotracheal gas and oxygen (Major J F Bereen, RAMC). The tracheal tube was passed with ease. An incision was made along the anterior border of the left sternomastoid muscle. There was much oedema of the subcutaneous tissues. On aspiration, thin offensive pus in small quantity was obtained. The deep fascia was then incised. Diffuse suppuration was present. A finger was pressed upwards along the separated tissue planes as far as the cornu of the hyoid bone, and downwards to the sternoclavicular joint. No localizing abscess was found. Two corrugated drains were inserted and the wound lightly closed.

The patient's condition was critical on return to the ward at 19.35 hr. Penicillin was continued until 22.00 hr, the total amount administered being 185,000 units. He did not recover consciousness, and died at 00.15 hr on Feb 24.

Examination of fluid aspirated from neck at operation 1 cc of blood-stained, watery pus. Direct film—moderate number of pus cells. Numerous Gram-positive cocci and bacilli of varying shapes and sizes, with a few Gram-negative bacilli.

Culture	Aerobic	{	Hæmolytic streptococci, moderate growth
			Coliform bacilli, slight growth
	Anaerobic	{	Hæmolytic streptococci, heavy growth
			Coliform bacilli, slight growth

Penicillin sensitivity factor of hæmolytic streptococci = 0.5

**AT AUTOPSY** (Major A D Morgan, RAMC)—The whole of the soft tissues covering the front of the neck were generally swollen with oedema from the mandible to the manubrium sterni. The pharyngeal wall itself was swollen, but there was no oedema of the glottis. The left mylohyoid muscle was swollen and necrotic, and contained a small abscess. On the inner aspect of the mandible, just below the left mylohyoid ridge, was an area of bone, denuded of periosteum, in the centre of which was a small opening 1 mm in diameter (Fig 103) which proved to be a sinus leading to a localized abscess at the root of  $\overline{7}$ . Removal of a window of bone from the outer aspect of the mandible revealed a similar abscess at the root of the unerupted  $\overline{8}$  (Fig 104). Following upon rupture of the subperiosteal

abscess on the lingual aspect of the mandible, the adjacent mylohyoid muscle had become involved, and from this focus a diffuse suppurative inflammation had spread rapidly through the soft tissues of the neck. At many points the intermuscular septa were gelatinous with oedema, and small pockets of thin yellow pus had formed

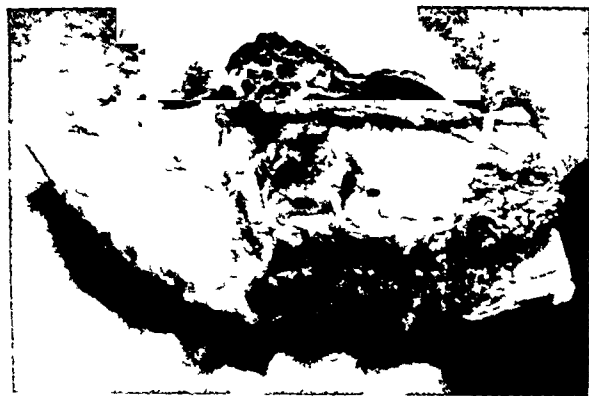


FIG 103—Left angle of mandible, inner aspect. A bare area of bone denuded of periosteum, lies below 7, the lingual aspect of which can just be seen. In the centre of this area is a small sinus communicating with a cavity at the roots of 7

(1) deep to the sternothyroid and sternohyoid muscles, (2) surrounding the right lobe of the thyroid gland, (3) between the upper oesophagus and prevertebral muscles, (4) in the superior mediastinum and peribronchial tissues, and (5) in the posterior mediastinum, representing the lowest limit of infection. Bacteriological culture of these abscesses yielded a growth of anaerobic haemolytic streptococci (penicillin sensitivity factor, 0.5), and coliforms



FIG 105—Left angle of mandible. Showing temporary dressing of zinc-oxide eugenol-resin in 7

Removal of the dressing from 7 (Fig 105) revealed a surface which was smooth, blackened, and macroscopically sound. Careful probing, however, revealed a minute area of softened dentine, through which a sharp-pointed instrument passed into the pulp chamber.

**Histology**—Sections of the mylohyoid muscle showed the necrotic muscle-fibres widely separated from one another by a highly cellular, acute inflammatory exudate (Fig 106). There was obviously no attempt at tissue reaction to confine the spread of infection, which could be seen extending along the fibrous septa accompanied by a profuse serous exudate and small haemorrhages.

The X-ray appearances of the angle of the mandible (post-mortem) are shown in Fig 107



FIG 104—Left angle of mandible, outer aspect. A window of bone has been removed to expose abscess cavities at the roots of 7 and the unerupted 8



FIG 106—Mylohyoid muscle. Showing the unrestricted spread of an acute inflammatory exudate between the degenerate muscle-fibres and along the tissue planes ( $\times 225$ )



FIG 107—Radiograph showing cavities in the periapical bone in relation to both 7 and 8

## SUMMARY

1 A case of alveolar abscess in relation to 7 progressing rapidly through the stages of cervical cellulitis to mediastinitis and death, is described

2 A dressing had been inserted in 7 some months previously, following which the tooth remained symptomless until three days prior to

admission. An unerupted left third molar was also present with areas of apical osteitis in relation to both  $\sqrt{7}$  and  $\sqrt{8}$ .

3 Diffuse swelling of the neck occurred following upon perforation of the lingual plate of the mandible and rupture of a subperiosteal abscess in  $\sqrt{7}$  region. The predominant symptom in the later stages was extreme dysphagia, becoming complete some hours before death.

4 Parenteral penicillin was administered with apparently little effect. Culture of organisms from the mouth, and later from pus, produced a hæmolytic streptococcus of relatively low penicillin sensitivity.

5 Autopsy revealed a widespread, fulminating infection of the neck which had extended to the superior and posterior mediastinum, with little or no tissue reaction to limit the spread of infection. The aetiological factors of this lessened resistance are not known.

6 Removal of the dressing from  $\sqrt{7}$  revealed a macroscopically sound dentine surface. Examination with a probe disclosed a minute area of softened dentine, leading to the pulp chamber.

### CONCLUSIONS

1 The danger of an acute alveolar abscess in the lower molar region perforating the lingual plate of

the mandible is well known. When the perforation occurs superior to the attachment of the mylohyoid muscle, the condition known as Ludwig's angina is likely to ensue, with associated gross œdema of the floor of the mouth and possibly of the glottis. In this case the perforation occurred below the mylohyoid ridge, and rapidly became of a widespread nature with involvement of the mediastinum. The respiratory passages were involved only to a small extent.

2 Chemotherapy was not continued subsequent to admission owing to the extreme dysphagia and the fact that penicillin was immediately available. Later, when the penicillin sensitivity factor of the organism was found to be relatively low, intravenous chemotherapy might with advantage have been instituted.

3 Conditions predisposing to acute medullary infection of the mandible may remain unsuspected for considerable periods before passing into an acute and gravely dangerous stage.

Our thanks are due to Colonel G. H. Haines, M.C., O.C. 15 (Scottish) General Hospital and to Colonel B. E. Gentleman, D.D.S., M.E.F. We are indebted to Major-General J. C. A. Dowse, C.B.E., M.C., D.M.S., M.E.F., for permission to publish this article. The accompanying photographs are the work of Pte P. Wood, R.A.M.C.

## DERANGEMENT OF MIDGUT ROTATION PRODUCING VOLVULUS

### A REPORT OF TWO CASES

By C. E. P. MARKBY

DEVELOPMENTAL errors in the disposition of the midgut are due to the complicated evolution through which the midgut has to traverse in order to obtain its normal position.

At the fourth week of intra-uterine life the greater part of the midgut is extruded from the main abdominal cavity. When the intestines re-enter it, they undergo three stages of rotation. The first stage is a simple one, and consists of an anti-clockwise rotation of the whole of the midgut through  $90^\circ$ . The second stage is the crucial phase. The midgut is rotated through a further  $180^\circ$  in an anti-clockwise direction. The first part to enter is the proximal end—namely, the duodenum and jejunum. They encounter the resistance of the liver, and are deflected to the right under the axis of the superior mesenteric vessels, which are held taut by the cæcum, still retained within the umbilical cord. Thus, the uppermost portion of the coil, the terminal part of the duodenum, comes to lie behind the vessels. The jejunum and ileum follow the same course. When the cæcum eventually returns to the abdominal cavity, the small intestines lie to the left, with the colon to the right. The third stage is the descent of the cæcum and proximal colon to the adult position.

Derangements of the first stage of rotation are very rare, and are only met with in extroversion of the cloacæ, whilst those of the third stage commonly occur with non-descent, or abnormally high fixation, of the cæcum.

Derangements of the second stage of rotation have been classified by Dott (1923) as—

1 *Non-rotation*—The gut, on re-entering the abdomen fails to rotate, the small intestine remaining on the right and the proximal colon on the left. The duodenum descends from its normal fixed part to the right of the mesenteric vessels, with the coils of the small intestine occupying the right side. The lower part of the ileum, passing across the midline, enters the cæcum on its right side. The ascending colon lies to the left of the midline.

2 *Inverse Rotation*—Rotation takes place through  $90^\circ$  in a clockwise direction, the proximal colon re-entering the abdominal cavity first, lying in a tunnel deep to the mesenteric vessels.

3 *Mal-rotation*—When the small intestine passes in front of the mesenteric vessels, the cæcum also passes in front, but further progress to the right is arrested by the misplaced small intestine, and the cæcum remaining in the subpyloric area.

The commonest pathological sequel of non-rotation is a volvulus. If the whole of the midgut remains free, suspended from a narrow duodenocolic isthmus, it is very apt to undergo volvulus, the whole of the midgut twisting around the axis of the mesenteric vessels. It often occurs in the first few days of life, producing a volvulus neonatorum. The diagnosis can be made clinically, when a young infant commences to vomit bile-stained material repeatedly. Volvulus implicating the post-arterial

segment, producing a twist of the terminal ileum, cæcum, and ascending colon, occurs later in adult life

### CASE REPORTS

The following is a report of a case of volvulus implicating the pre-arterial segment, due to non-rotation —

**HISTORY**—P T, female child, aged 7½ years Birth weight, 6 lb 12 oz Normal delivery Third child Rest of family well Breast fed for 8 months The child began to vomit when three days old, and vomiting

She was re-admitted in March with loss of weight and continued attacks of vomiting

**ON ADMISSION**—Her general condition was poor, and she appeared to be very dehydrated Her weight prior to operation was 1 st 10 lb She had no pyrexia, but was vomiting nearly every day about 30 oz of clear greenish bile-stained fluid *Radiological examination* was undertaken by Dr Buckley, whose report was as follows —

“X-ray before operation A screen examination in the upright positions showed three fluid levels before any barium was swallowed These were found to be



FIG 108—Before operation—first opaque meal Shows dilated stomach and duodenal cap, both with fluid levels above the barium, possibly distended 2nd and 3rd parts of duodenum, and fluid level just distal to duodeno-jejunal flexure

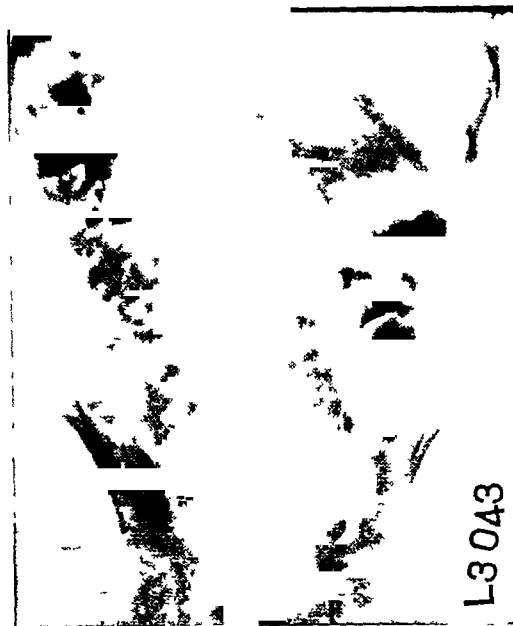


FIG 109—First meal—24 hr p c Shows displaced cæcum along ascending colon, lying below and parallel to the transverse colon The terminal ileum can be seen on the mesial aspect of the cæcum

occurred directly after most feeds She was always constipated, and required frequent enemas The vomiting continued until she was weaned, in spite of this, she managed to gain weight steadily

The vomiting returned when she was 16 months old, but the quantity was smaller Bowels were open once a week

When she was 3 years old she developed a tuberculous cervical abscess, which was incised and curetted, but failed to heal She was sent to a convalescent home for 6 months, during which time she had periodic attacks of severe vomiting

When she was 5 years old she was admitted to a local Cottage Hospital for acute obstruction She had been suffering from excessive vomiting, and there had been no bowel action for 14 days She responded to stomach washouts and enemata, and was discharged after 3 weeks She then made satisfactory progress for a year, with no vomiting, and her bowels were open regularly with small doses of agerol

When she was 6½ years old her vomiting attacks returned At this time she was thought to be a case of tuberculous peritonitis, and was re-admitted to the children's convalescent home Nothing abnormal was found

She was admitted to the Royal Victoria and West Hants Hospital in January, 1941, on account of repeated attacks of vomiting Her weight was 2 st 5 lb Her abdomen was distended and tympanic, but there was no dullness in the flanks or evidence of free fluid Mantoux test was positive She gained 3 lb in weight and was discharged after a month

in the dilated stomach and the duodenal cap, and in the region of the duodeno-jejunal flexure After the barium had been swallowed, the second and third parts of the duodenum suggested that the third fluid level was just distal to the duodeno-jejunal flexure In the absence of tenderness, it was thought that the duodenal ileus must be caused by pressure from an abnormally situated superior mesenteric artery There was still a trace of barium in stomach and duodenal caps at 48 hr p c A film taken 24 hr p c at first gave the impression that the colon was completely transposed, especially as the flexure in the left was lower than that on the right Subsequent events, however, proved that the coil thought to be the descending colon was, in fact, the elongated ascending colon lying below and parallel to the transverse colon” (Figs 108, 109)

**AT OPERATION**—A laparotomy was undertaken Anæsthetic given by Dr Montgomery consisted of ethyl chloride and open ether The stomach and first and second parts of the duodenum were moderately dilated, but were normally situated and attacked The third part of the duodenum was more distended, but was normally placed in the retroperitoneal tissues, behind the mesenteric vessels The site of the obstruction was at the beginning of the jejunum, which turned sharply to the right under the mesenteric vessels It then spiralled round the mesenteric vessels in a clockwise direction for three complete turns There was no obstruction to the vessels, and no engorgement of the loops The volvulus was easily reduced by rotating

the whole mass of small intestine on its axis in an anti-clockwise direction

When the twist was undone, it was found that jejunum, distal to the twist, was piercing the mesentery of a lower loop of the jejunum. From this point the small intestine ran in a normal manner, occupying the right side of the abdomen. The terminal ileum then crossed the mid-line and entered the cæcum at its normal situation. The base of the mesentery was shorter than normal, starting at the usual situation to the left of the second lumbar vertebra at the duodeno-jejunal fold, and running downwards to the right for only  $1\frac{1}{2}$  in. The mesentery was

residual fluid. The duodenal cap was deformed in shape but no barium would pass beyond this point until the child had been placed on the right side on the X-ray table. After this it made rapid progress, and the whole alimentary canal was free of barium at 24 hr p.c. A film taken 8 hr p.c. shows the new position of cæcum and ascending colon, with traces of barium in stomach and duodenal caps" (Figs 110, 111)

**Comment**—The diagnosis of this case was made by radiological examination, and the lesion was located to the terminal portion of the duodenum,



FIG 110—After operation—second meal. Stomach now of normal size, but still containing a little residual fluid. Duodenal cap contracted and deformed in shape.



FIG 111—Second meal—8 hr p.c. Cæcum and ascending colon restored to normal position. Traces of barium in stomach and duodenal cap.

foreshortened. The cæcum was lying in the left hypochondrium, below the terminal portion of the transverse colon, and was anchored to the splenic flexure by peritoneal bands. The ascending colon appeared to have a mesentery which had become adherent to the transverse mesocolon. It was running transversely across the abdomen, just below the transverse colon, to the hepatic flexure, which was situated in its normal position, below the liver, in the right hypochondrium. The transverse colon, splenic flexure, and descending colon were occupying normal positions. The sigmoid colon seemed to be slightly longer than usual, and was more centrally placed. The rectum was normal. A duodeno-jejunostomy was performed, a side-to-side anastomosis being made between the distended third part of the duodenum and a portion of the jejunum distal to the point where it pierced the mesentery. The cæcum was then mobilized by dividing the bands, which held it to the splenic flexure. The cæcum and ascending colon were separated from the transverse mesocolon and swung over to the right. A cæcoplexy was performed. The posterior parietal peritoneum was incised and mobilized, and the cæcum and ascending colon were then tucked into the pocket and anchored by means of interrupted sutures passing through the anterior longitudinal band of the cæcum to the cut edge of the parietal peritoneum.

**PROGRESS**—The child has made an uneventful convalescence, and has had no recurrence of attacks. Now, four years later, she is a well-developed girl with a normal weight.

**Radiological examination after operation**—"A screen examination showed stomach and duodenal cap reduced to normal size, but the former still contained some

when it was thought to be compressed by the mesenteric vessels as in the case of duodenal ileus. The obstruction, however, was due to a volvulus of the upper end of the jejunum, around the mesenteric vessels. The age of the patient, and the exact localization of the obstruction, ruled out pyloric stenosis, congenital atresia of the intestine, and obstruction from a persistent Meckel's diverticulum. A mesenteric cyst or loop of bowel caught in a patent duodenal fossa might have been the cause. Volvulus neonatorum caused by a twist of the jejunum around the mesenteric vessels usually manifests itself within a few days of life, and is invariably fatal. It is interesting to note that the signs of obstruction did manifest themselves shortly after birth, as it is difficult to see how the whole of the small intestine could have possibly rotated itself through three complete circles but was not sufficient to occlude the bowel or produce strangulation. The extremely rare condition of the small intestine piercing its own mesentery, should be noted.

The following case illustrates a volvulus implicating the post-arterial segment due to an inverse rotation—

**HISTORY**—G. S., a woman aged 49 years, was admitted with intestinal obstruction. She had had colicky pains over the lower part of the abdomen for eight days. She had commenced to vomit three days prior to admission, the vomits were bilious at first, and

then were tending to become faecal. She had had absolute constipation for five days. She had experienced

a previous attack six months ago, but it had passed off. An enema, given before admission, produced no result.

**ON ADMISSION**—She was a well-covered woman with an obvious abdominal distension. No mass could be felt, but there was some shifting dullness detected in the flanks. Audible peristalsis could be heard over the abdomen. On rectal examination nothing could be felt, but there was some peritoneal tenderness over to the right, and an indeterminate mass was thought to be present on bimanual examination.

**AT OPERATION**—A laparotomy was performed under a spinal anaesthetic. The abdomen was opened through a left paramedian incision, and was found to contain some free fluid. The cæcum was very distended and congested, and had undergone a twist through 180° round the ascending colon. When the volvulus was unwound it was seen that, at the neck of the volvulus, the ascending colon disappeared into a retroperitoneal tunnel. It then ran upwards and to the left behind the root of the mesentery and the mesenteric vessels, to emerge at the normal splenic flexure. In order to fix the cæcum, a cæcostomy was performed, and a self-retaining catheter was inserted into the cæcum and brought out through a stab incision in the right iliac fossa. On return from the theatre, the patient's condition was very poor, and she died some thirty-six hours after the operation.

Post-mortem examination showed that she had died of a pulmonary embolus. The abnormal arrangement of the bowel was confirmed and is shown in the accompanying drawings (Figs 112, 113).

My thanks are due to Dr Buckley for her extremely helpful radiological examination and report, and also to Dr Morse and Mr Chilver Stainer for their drawings.

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FIG 112—The condition found post mortem



FIG 113—Showing in greater detail the anatomical abnormality

## RESECTION OF THE HEAD OF THE PANCREAS

BY CHARLES A. PANNETT

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CARCINOMA of the head of the pancreas frequently arises near the opening of the common duct, when obstruction to this structure gives early notice of its presence, or it may grow more distantly in the head and exist for some time before it spreads and hinders the outflow of bile. An example of the successful removal of each of these types of growth is reported here. They were removed in the simplest fashion, in one case without premeditation, by the use of ordinary, simple, long-established surgical methods.

In the first, a large piece of the pancreatic head, up to the level of the superior mesenteric artery, with all the duodenum except the end of the third part, was removed. The second resection was carried out in a woman also very deeply jaundiced. In her case, the whole of the head of the pancreas was taken away.

Several problems come to the fore when growths of the pancreas are removed, and they are not yet settled. One is whether the operation should be carried out in two stages, as advocated by Whipple (1935), that is, a primary cholecyst-gastrectomy with section and ligation of the common duct, combined with a gastrojejunostomy, followed later by removal of the growth, or whether the whole procedure be done in one stage. Hunt (1941) has operated in two stages successfully, and so has Child (1944), though he has been equally successful with a one-stage operation, and Whipple (1945) has recently declared himself in favour of doing everything at one time. On the other hand, Watson (1944) is a strenuous advocate of two stages. The chief argument in favour of two stages is the relief of the patient from the toxæmia of biliary obstruction at the primary operation, so that when the major procedure is done he will be the more able to withstand it. But both my patients went through a one-stage operation although there was intense jaundice which had been present for three months. In neither was there any abnormal tendency to bleeding. Vitamin K had been administered to one of them. An objection to two stages is the difficulty with adhesions at the second operation. It would seem better to do everything at one time unless the patient is extremely weak and feeble.

The next problem is what to do with the cut surface of the pancreas. If only a wide V is resected from the head it does not seem practical to implant the extensive raw surface into the jejunum, but if the whole head be removed the cross-section of the neck is not too large to do this. Physiologically it would seem much better that some pancreatic juice should enter the intestine.

Experimentally in animals fatty degeneration of the liver is said to take place after ligation of the pancreatic duct or total pancreatectomy. However, in man this does not appear to be the case, and ligation of the pancreatic duct with sewing over of the raw surface is allowable. In my patient nine months

later there is apparently normal digestion. He eats what he likes, has no distaste for food, and has raised his weight from 7 st 11 lb to 11 st. Three weeks after the operation, indeed, the soaps and fatty acids in the stool amounted to 87.3 per cent of the total fats. At that time there were a few undigested muscle-fibres and starch granules to be found. The outcome, however, is not always so happy, as reports of deficient fat digestion have been made in some patients. Thus, Whipple (1945), in his case which had no jaundice, found a 30 to 50 per cent fat loss in the stools. Technically, the implantation of the pancreas into the bowel is not attractive. The capsule of the pancreas is thin, it does not take stitches well, and the passage of the needle may allow pancreatic juice to escape from the needle holes, which, activated by kinase leads to digestion of the fibrin upon which depends the water-tight joint. In my patient, in whom I implanted the pancreas, a watery discharge occurred on the fourth day which I took to be pancreatic juice. Unfortunately it soon became a purulent exudation and led to disruption of the abdominal wall, necessitating re-suture ten days after her operation. The man whose pancreas had been sewn over also discharged pancreatic juice on the fourth day, which later became tinged with bile. But in ten days it had almost ceased and the wound was nicely healed. In any case it is essential to place a drainage tube down to the neighbourhood of the cut pancreas or the implantation. Also, it would seem better to use interrupted silk or cotton sutures in place of easily digested catgut.

The third problem is how to restore the flow of bile into the alimentary canal. It is very odd that surgeons should select an anastomosis between the gall-bladder and stomach or intestine with nothing but a simple ligature to close the common duct. When this ligature sloughs away bile must frequently escape from the end of the duct. Always the bile-duct should be implanted into the intestine. This is not difficult, as it is dilated.

The restoration of the alimentary canal should be made by an end-to-side anastomosis between the cut end of the stomach and the jejunum. I divide the stomach across just proximal to the pylorus and the duodenum to the right of the superior mesenteric artery, leaving just enough for in-turning. It does not seem necessary to go to the extent of displacing the duodenojejunal flexure beneath the mesenteric vessels so that the first part of the jejunum may be cut across. Although the third part of the duodenum at this stage is denuded of peritoneum, closure in the ordinary way appears to be quite safe.

For the anastomosis in both my patients a long loop of upper jejunum was taken and thrown over to the right of the abdomen, so that forward peristalsis would run from right to left. The common bile-duct, the neck of the pancreas, and stomach were implanted in separate holes in this order also from

right to left in one, the bile-duct and the stomach in the other. The reason for this is that as there must be a considerable length between the duodeno-jejunal flexure and the place of entry of the gastric juice, it is advisable to have bile and pancreatic juice already in the bowel at this point in order to diminish the risk of a jejunal peptic ulcer.

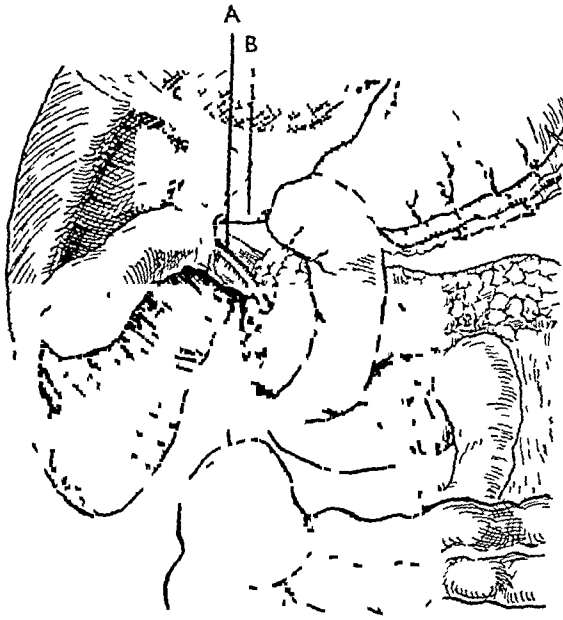


FIG 114 —The hepatic flexure has been pushed downwards off the duodenum, the greater and lesser curvatures of the stomach near the pylorus freed, and the duodenum reflected to the left—exposing the vena cava inferior and the common bile-duct. A, Common bile-duct lying on portal vein, B, Hepatic artery.

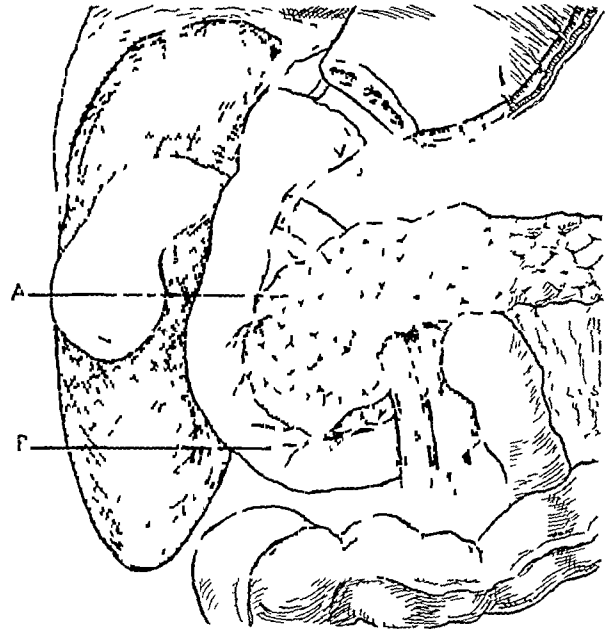


FIG 115 —The stomach has been cut across, the superior mesenteric vessels freed, and the portal vein dissected away from the pancreas. A, Superior pancreaticoduodenal vein, B, Inferior pancreaticoduodenal vessels.

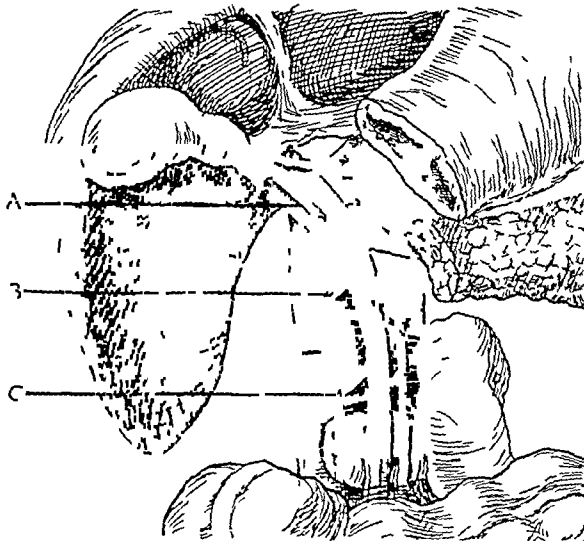


FIG 116 —The pyloric fragment of stomach and the duodenum with the whole of the head of the pancreas have been removed. The pancreatic duct is seen in the section of the neck of the gland. Distal end of duodenum closed. A, Common bile-duct lying on portal vein, B, Superior pancreaticoduodenal vein, C, Inferior pancreaticoduodenal vessels.

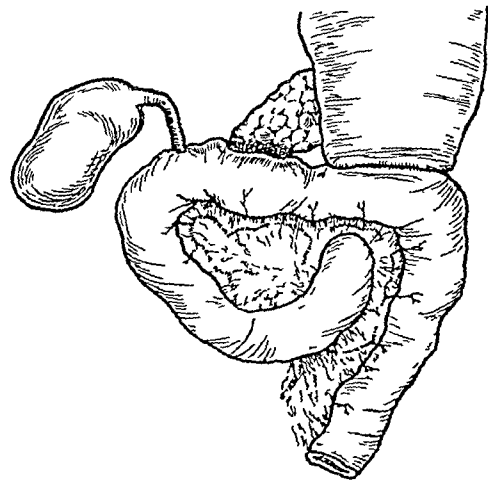


FIG 117 —The common bile-duct, the neck of the pancreas, and the pyloric end of the stomach have been implanted severally into the first loop of the jejunum.

down. The lesser sac will have been opened in the primary exploration. Now about  $1\frac{1}{2}$  in of the greater and lesser curvatures of the stomach are laid bare, and the stomach cut across between clamps just proximal to the pylorus (Fig 115). The gall-bladder, tightly distended, is emptied by suction and the puncture oversewn. The peritoneum is incised to



the right of the second part of the duodenum and the cut carried upwards to meet the opening in the lesser omentum. The duodenum and head of the pancreas are easily lifted off the vena cava and turned over to the left, exposing the entrance of the common bile-duct into the pancreas (*Fig 114*). The duct is divided and lightly clamped about  $\frac{1}{2}$  in from its end. The next stage is more difficult. It is getting the uncinate process of the head from between the superior mesenteric vessels in front and the vena cava behind. The superior mesenteric vein must be traced for all its length until it becomes the portal vein. In the course of this dissection the neck of the pancreas is cut across, the gastroduodenal artery and its gastro-epiploic branch ligatured and divided, the superior pancreatico-duodenal vein severed as it joins the superior mesenteric or portal vein, and the inferior pancreatico-duodenal artery and vein dissected out, divided, and ligatured (*Fig 115*). The duodenum is freed to the superior mesenteric vessels. It is clamped about  $\frac{3}{4}$  in from them, cut across, and closed by a doubly invaginating suture. I used a continuous catgut suture for this, but for everything else, except the implantation of the stomach, cotton was employed. The duodenum and the whole of the head of the pancreas together with the growth are now freed and can be removed (*Fig 116*). The first part of the jejunum is carried up in front of the transverse colon to the right of the abdomen and placed so that it runs transversely from right to left. The bile-duct is now implanted into a hole in the jejunum. Four cotton sutures suffice to join it to the opening, after which the anastomosis is invaginated by a few Lembert stitches. About 1 in farther along a larger hole is made for the neck of the pancreas. This also is implanted with two rows of separate cotton stitches. Then a little farther on still the stomach is implanted in the ordinary way, a continuous catgut suture being used (*Fig 117*).

If the whole head of the pancreas is not excised, but only a V-section made, the pancreatic duct is ligated and the raw surface closely oversewn. In either case a drainage tube must be left going down to the neighbourhood of the cut pancreas or its implantation.

The abdomen is closed.

The after-treatment does not differ from that of any serious abdominal operation. Removal of the whole head took two hours and fifty minutes. This patient received 2 pints of blood afterwards. But the other patient was so well that a blood transfusion was not necessary. His convalescence was without any incident except for the pancreatic fistula already mentioned. He was up, with his wound healed, on the nineteenth day.

The woman who lost the whole of the head of the pancreas did not fare so well. The wound became septic and had to be re-sutured on the tenth day. Gram-positive cocci, diplococci, and colon bacilli were in the pus and penicillin did not control the infection. For two months this suppuration went on, necessitating the opening of two small abscesses in the lower part of the abdominal wall. But all this time the general condition was good, the jaundice disappeared, and the appetite returned. Not until two months and three days had elapsed did the patient leave the hospital healed and well.

## CASE REPORTS

*Case 1*—H L, male aged 50, a carpenter, a patient of Professor Pickering, had had jaundice, itching, loss of appetite, and general malaise, with light motions and dark urine for three months.

ON EXAMINATION (July 26, 1945)—His liver was much enlarged and the gall-bladder felt distended. There was intense jaundice. The serum-bilirubin was 5 mg per 100 c.c. A diagnosis of carcinoma of the pancreatic head was made.

OPERATION (July 30)—A resection up to the level of the superior mesenteric vessels was carried out as described above.

*Microscopical Report* Papillary tubular columnar-cell, sometimes trabecular polygonal-cell, carcinoma invading head of pancreas and intestinal mucosa at ampulla of Vater.

Pulse rose from 68 at the beginning to 82 at the end of the operation. It only rose to 84 the next day. He absorbed 4 pints of rectal water the night of the operation and 4 pints the next day.

Aug 4. Clear fluid began to escape from the drainage tube and became a profuse flow. It was pancreatic juice and caused some reddening of the surrounding skin. Zinc cream was used to protect the skin. Powdered aluminium could not be obtained. The wound remained soundly healing. The discharge became tinged with bile.

Aug 14. Discharge from tube scanty. Jaundice gone. Stools normal. Eats almost anything.

Aug 19. Wound healed. Patient out of bed.

Aug 20. Stool examination. A moderate number of partly digested muscle-fibres and a few starch granules. Also a few fat globules and an occasional pus cell. Soaps 60.9 per cent total fatty bodies, fatty acids 26.4 per cent, neutral fats 12.7 per cent.

April 15, 1946. Patient extremely well. Eats anything. Working as carpenter. His weight has gone up from 7 st 1 lb to 11 st.

*Case 2*—K S, female aged 50, a patient of Professor Pickering. Three months ago began to suffer from headache, lassitude, vomiting, and jaundice. She suffered from itching, the stools were pale and the urine dark.

ON EXAMINATION (Nov 26, 1945)—A very thin woman, deeply jaundiced, with very much enlarged liver and a palpable gall-bladder. Skin had many scratch marks. Stools pale. Urine contains bile.

Blood-proteins 5 per cent, albumin 2.8 per cent, globulin 2.2 per cent. V-d-B reaction immediately red, violet in three minutes. Bilirubin 12 mg per 100 c.c. Serum-cholesterol 527 mg per 100 c.c.

Vitamin K (10 mg) with bile-salts (325 mg) was given twice a day for five days. Also glucose by mouth.

OPERATION (Dec 10)—The whole pancreatic head was removed as described above.

*Microscopical Report* Alveolar, tubular, and trabecular cubical- and polygonal-cell carcinoma of the pancreas invading duodenum and lymph-gland. Mitotic figures scarce.

Rectal water given and 2 pints of blood transfused after the operation.

Dec 14. A profuse watery pancreatic discharge has begun.

Dec 16. The discharge has now become purulent. The patient has vomited several times. Ryle's tube passed, and glucose given intravenously.

Dec 17. Ryle's tube again passed and left down for 30 hours. Discharge purulent and copious.

Dec 20. General condition good since Ryle tube removed, but wound margins separating. Wound resutured. To have systemic penicillin for five days.

Dec 22. Less discharge, though still a fair amount. No vomiting. Slight distension. Jaundice much less.

During all January, 1946, pus continued to issue from the wound. It contained cocci in small numbers, diplococci, and colon bacilli which did not seem sensitive to penicillin. Also many *B. proteus* were present. The general condition of the patient was steadily improving, however.

On Jan 6 and Jan 11, 1946, pockets of pus were drained in the lower part of the wound. The upper part which led down to the site of the excision was at this time healed. The jaundice had disappeared and the appetite was good. It was not until Feb 15 that the discharge of pus finally ceased, and the patient was discharged 67 days after her operation.

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## BRODIE'S DISEASE OF THE BREAST

By DAVID AIKEN

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IN 1846, Sir Benjamin Brodie published his "Lectures Illustrative of Various Subjects in Pathology and Surgery". In one of the lectures he gave a description of the condition which is recognized to-day as Brodie's disease of the breast. It is just a hundred years since the classical account appeared, and it is opportune, therefore, to consider the present conception of this tumour, which is often confused with carcinoma and sarcoma, although it belongs to the fibro-adenoma group and is essentially benign.

## HISTORICAL NOTE

Unusually large non-cancerous breast tumours were recognized early in the nineteenth century, and the first account in British literature appeared in 1827, when Dr Cumin, of Glasgow, recorded a typical case. The breast tumour was as large as a child's head and weighed 57½ oz. It was successfully removed, and ten years later there was no sign of recurrence. In 1829, Sir Astley Cooper drew attention to similar breast neoplasms and described them as the "second species of hydatid disease". His description is worthy of quotation —

the patient, "ætat 58, had an enormous enlargement of her left breast, which she first discovered 18 years ago, and then supposed it arose from a blow. When she first observed it, its size was that of a marble, it felt hard, and was unattended with pain."

"It appeared to be buried in the substance of the breast, and was not very movable in the glandular structure. It increased gradually until two years ago, by which time it had acquired the size of a melon. At that period it seemed to increase suddenly, and to grow faster than before, but it was still unattended with pain, and her general health did not appear to suffer."

"On the 30th September, 1822, I first saw her, and the tumour then measured thirty-five inches in circumference, in the greater part it was solid, but in other parts it was soft and fluctuating, and one bag evidently contained a large quantity of fluid. Her general health was good, but she suffered much from its weight drawing down the skin and pectoral muscle, and putting the nerves exceedingly upon the stretch."

The tumour which he removed is illustrated by an excellent coloured plate in his book.

In 1838, Johannes Muller, in Germany, gave an account of several cases of this disease, calling it cystosarcoma phyllodes because of its leaf-like appearance. He distinguished this growth from other breast lesions and stressed its non-malignant nature.

The next clear description of the clinical and pathological features of the condition was that of Sir Benjamin Brodie (in 1846). He, and his contemporary, Cooper, regarded the neoplasm as an advanced stage of cystic disease of the breast, but Brodie's penetrating observations and gift of graphic description earned him the deserved honour of the eponym. In his classical account, he states —

"the disease had probably been of long duration, the breast had attained an enormous size, being not less than seven pounds in weight. She was a middle-aged person, otherwise in good health, and the skin and axillary glands were free from disease. The diseased breast was amputated. The wound healed favourably, and I heard of the patient being alive and well several years afterwards."

Since Brodie's day, numerous and confusing names have been applied to this type of tumour—for example, cystosarcoma, fibrolipoadenoma, intracanalicular sarcomatodes, xanthomatodes, mammæ, etc (Owens and Adams, 1941), but the majority of these should be discarded because they classify it as a sarcoma. Brodie stressed its non-malignancy when he observed "the disease seems to be entirely local. It belongs to the breast and nothing else. It does not contaminate either the skin or lymphatic glands."

It appears to have been a rare tumour in his day and it is so still. Only 125 cases have been recorded to date in the medical literature (Lee and Pack, 1931; Owens and Adams, 1941; Cooper and Ackerman, 1943), but it may be more frequent than is generally believed. Dr H. Russell, Pathologist of the Christie Hospital and Holt Radium Institute, informs me that she has reported it four times among the last four hundred and forty specimens of tumours of the breast (of all kinds) which have passed through her hands, but in only two of the four was the whole tumour received for study.

## CASE REPORT

**HISTORY**—On Feb 12, 1945, Mrs B, a mill worker aged 68, consulted her doctor on account of a lump in the right breast (*Fig 118*). On seeing the breast he immedi-

**TREATMENT**—On Feb 26, 1945, under pentothal and gas-oxygen anaesthesia, a right simple mastectomy was performed by the writer, using a transverse elliptical

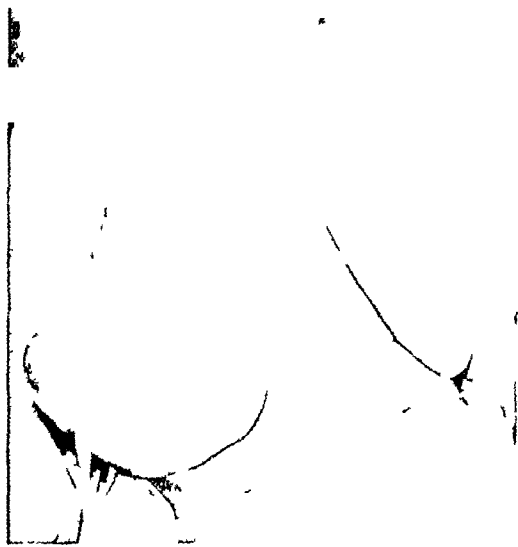


FIG 118—Clinical photograph of patient on admission

ately referred her to the Clinic, where she came under the care of Mr Wilson Hey

**Past History**—The patient had always been healthy. She had had five pregnancies which were normal and the children were nursed from both breasts without difficulty. During her first pregnancy, when 28 years old, the doctor in charge discovered a small lump in the upper outer quadrant of the right breast. This was no larger than a cherry and symptomless and she decided against removal. At each succeeding pregnancy it became a little larger but almost "settled down" again in the intervals.

**Present History**—In 1940 the lump began to enlarge and thereafter steadily increased in size and weight. In 1944, following an injury, the tumour grew more quickly and the weight of the breast increased to such an extent that a sling was required to support it. She had no pain apart from a "dragging" sensation due to the weight. There was no nipple discharge.

**PHYSICAL EXAMINATION**—The patient was a well-nourished healthy woman, the heart, lungs, and central nervous system were normal, the breasts were pendulous, the right being lower than the left. The entire right breast was replaced by a bulky lobulated mass.

The skin overlying it was dusky in appearance, especially at the outer side, and the cutaneous veins were prominent. The nipple was normal. On palpation the tumour was found to be heavy, painless, and freely movable on the chest wall. The lobulations were produced by fluctuating superficial cysts. At the outer side the tumour was almost on the point of bursting through the skin. The consistency was firm apart from the cystic areas. There were no palpable axillary or supraclavicular lymph-nodes.



FIG 119—Photograph of gross specimen divided in half

incision. The tumour was exceedingly vascular. Removal of the pectoral fascia was unnecessary. One year later there was no evidence of recurrence.

**THE SPECIMEN**—The tumour weighed 2,370 g and measured 20 × 12.5 cm. It was lobulated and the cut surface revealed hard, white, pearly, whorled areas alternating with soft, degenerating, myxoma-like lobules, some of which had become cystic. Near the periphery were two or three hæmorrhagic areas. In the centre of the tumour was a large dilated duct (*Figs 119, 120*).



FIG 120—Drawing of tumour

**Histological Examination**—The white whorled areas showed the appearance of a cellular intracanalicular fibro-adenoma (Fig 121) and these merged into the myxoma-like lobules. The latter (Fig 122) were full of fibroblast-like cells extremely uniform in size and shape, some of them dividing. The mitotic figures were quite regular (Fig 123).

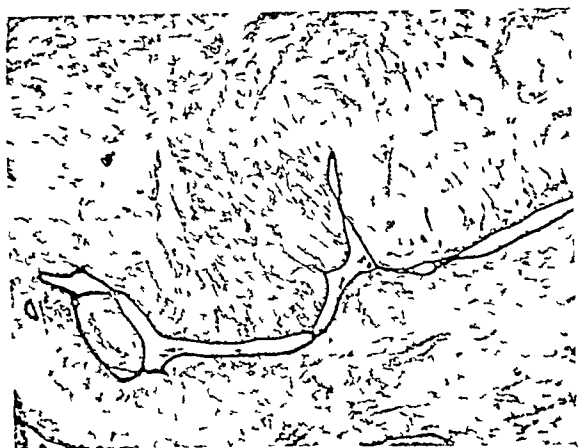


FIG 121—Low-power magnification, showing the intracanalicular fibro-adenoma pattern

degenerate into cysts. Microscopically its structure is that of an intracanalicular fibro-adenoma which has become very cellular and shows degeneration and even cystic softening. In the cellular areas of

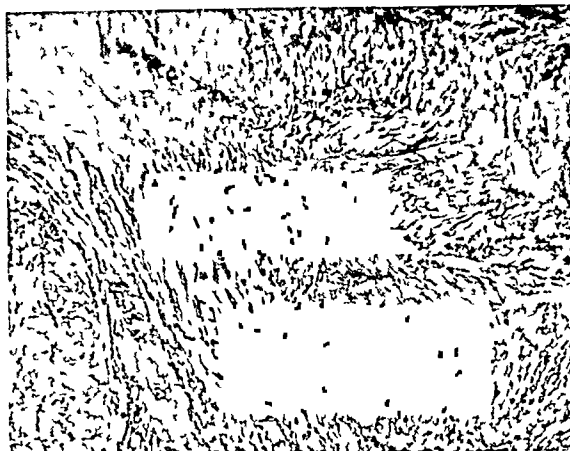


FIG 122—Showing myxoma-like areas

## DISCUSSION

The term 'Brodie's tumour' should be reserved for large excessively cellular and long-neglected fibro-adenomata. The history of a pre-existing breast tumour of many years' duration which at first grows slowly or not at all, and finally in late middle age increases rapidly in size, is the outstanding feature of a Brodie's tumour. Commencing as a fibro-adenoma, it maintains the characteristics of an innocent lesion throughout. The skin overlying the tumour is mobile, there is no fixation to the deep structures, and the lymph-nodes are not usually involved, apart from hyperplasia due to inflammatory changes. Enlargement may be so great that ulceration of the skin occurs from pressure necrosis, and the foul, fungating mass in a patient past middle life at once suggests a carcinoma\*. Sometimes the correct diagnosis of an innocent large tumour is impossible until the breast is removed. One striking clinical feature in typical cases is the excellent general condition of the patient.

Local recurrence following excision of the tumour has been reported on rare occasions, especially by the earlier writers, and convincing evidence of malignancy is even rarer. In the 125 cases referred to above, 4 were reported as sarcomas developing in a Brodie's tumour, but detailed study of the papers does not convince one that they were cellular tumours of the fibro-adenoma group which had become malignant.

The cut surface of a Brodie's tumour reveals an encapsulated mass showing white whorled areas, deep clefts, and translucent lobules, some of which

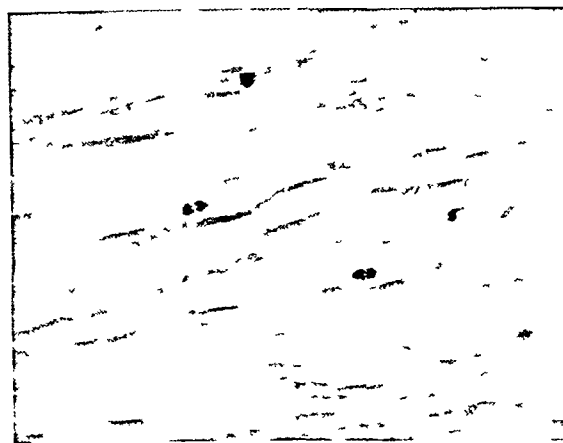


FIG 123—High-power magnification, showing the mitoses

fibroblasts dividing cells may be found, but the mitoses are regular. It is this appearance which may lead to the diagnosis of sarcoma.

The best treatment of Brodie's tumour appears to be simple mastectomy, rather than local excision, for care must be taken not to leave any breast tissue behind in the skin-flaps. It is possible that recurrence of the tumour may take place from a fragment remaining in situ as in simple tumours of the parotid gland. It has been suggested that the rapid growth of these fibro-adenomata in late middle life may be associated with diminished oestrogen activity.

## SUMMARY

A case of Brodie's tumour of the breast is reported.

It is recognized as a very large and long-neglected form of fibro-adenoma which is difficult to differentiate clinically from sarcoma (and sometimes carcinoma) of the breast.

Its essentially innocent character is maintained.

\* There was a verbal tradition in surgical circles after Brodie's day that this tumour could be distinguished from a fungating carcinoma because a probe could be passed deeply between the skin and the tumour, presumably around the fibrous capsule.

I have to thank Mr Wilson H Hey for permission to publish this case. I am indebted to Dr E R A Cooper for the photomicrographs, and to Dr H Russell for helping me with the pathology.

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## SHORT NOTES OF RARE OR OBSCURE CASES

### COMPLETE TORSION OF A FIBROID UTERUS WITH ITS ADNEXA

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TORSION of a large fibroid uterus, with both tubes and ovaries, would appear to be an exceptional occurrence worthy of record.

#### CASE REPORT

**HISTORY**—An unmarried woman, aged 51, was admitted to The Royal Cancer Hospital under the care of Mr R C B Ledlie, with severe abdominal pain of two days' duration. The pain was continuous and cutting in character, situated centrally in the abdomen and not radiating. Vomiting had at first been copious and the patient had been constipated. Her menstrual periods had been becoming scanty. She had been losing weight in spite of a protuberant abdomen.

Some eleven months previously she had suffered similar but milder attacks of pain, which had lasted for ten days.

**ON EXAMINATION**—The abdomen was distended with a large smooth tender mass which extended to within three inches of the xiphisternum. It inclined to the right side and caused a protuberance in the right loin (Fig 124). Intestinal sounds were normal. Pelvic examination showed that the cervix had been drawn up and was connected with the mass.

**AT OPERATION**—It was found that there was an exceptionally large fibroid uterus which had twisted through three half-turns ( $540^\circ$ ) in a clockwise direction, carrying with it both tubes and ovaries. The pelvic peritoneum and broad ligaments had stretched to allow of this degree of torsion and the whole mass was lifted out of the pelvis. The twisted pedicle consisted of the attenuated supra-cervical segment of the uterus wrapped round with both broad ligaments, round ligaments, and infundibulopelvic folds. The whole was intensely congested, particularly the tubes and ovaries, which were blown up and black.

Subtotal hysterectomy with bilateral salpingo-oophorectomy was done after untwisting the mass. Owing to the distortion of the pelvic floor the pedicle was dissected with considerable care to ensure that the ureters were not also looped up into the twist.

The patient made a straightforward recovery except for a urinary infection which responded to simple treatment.

(A radiograph and a tomograph of the chest revealed a uniform, well-defined opacity, 4 cm in diameter, in the hilum of the left lung. Further radiographs taken five weeks later have shown no change in this opacity. It was considered extremely unlikely, in view of the

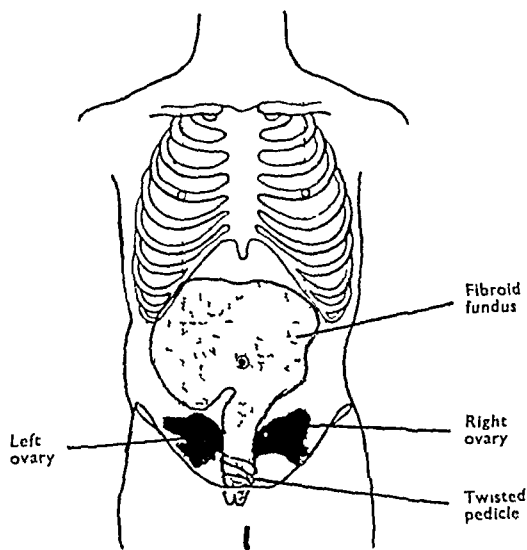


FIG 124—Drawing showing the abdominal distension

pathological findings, that this single large pulmonary mass was connected in any way with the uterine tumour.)

**THE SPECIMEN**—The specimen removed at operation is illustrated in Fig 125. It weighed 9 lb 10 oz, and measured 11 in in its vertical and maximum transverse diameters and 8 in antero-posteriorly. On hemisection the uterus was found to contain confluent fibroids (Fig 126).

The histology of the uterine tumours was that of typical fibroleiomyomata. There was no evidence of

Sections from the ovaries showed interstitial hæmorrhage, but no evidence of any ovarian tumour



FIG 125—The specimen



FIG 126—Section through specimen, showing confluent fibroids

any sarcomatous change or of any undue degenerative process. Conspicuous features were the intense congestion and engorgement of the intramural uterine vessels and the extensive degree of interstitial hæmorrhage.

We wish to record our thanks to Mr Ledlie for permission to publish this case. The patient was referred to The Royal Cancer Hospital by Dr A M Ross.

## ILEOCOLIC INTUSSUSCEPTION ASSOCIATED WITH NON-ROTATION OF THE MIDGUT, CONGENITAL HEART DISEASE, AND CONGENITAL HYDROCELE

By D P VAN MEURS  
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THIS case is put on record mainly to support the contention that lack of fixation of the ileocaecal region is an important factor in primary intussusception. The case provided an interesting diagnostic problem and also an example of the frequent multiplicity of congenital abnormalities.

### CASE REPORT

**HISTORY**—R J, male, aged 5 years, was admitted to hospital on May 12, 1945, with a history of intermittent attacks of colicky abdominal pain and vomiting for eight days. During the first two days of the illness the attacks were fairly frequent but not severe, and the patient was constipated. There were a few slight attacks of colic during the next four days, and the bowels were kept open with liquid paraffin. The attacks then gradually became more severe and frequent until they were occurring about every fifteen minutes and lasting about two minutes. He was constipated again, and no blood or mucus had been passed per rectum. On the day before admission a swelling had appeared in his scrotum.

He had been cyanosed since birth, and congenital heart disease had been diagnosed two years previously at another hospital. At this time a transient swelling had been present in his scrotum.

**ON EXAMINATION**—He was deeply cyanosed, with marked clubbing of the fingers, but apart from this his condition was good. The abdomen was slightly distended, and without tenderness or guarding. No mass could be felt except for the liver, which was enlarged to two fingers below the costal margin. The rectum was empty, and there was no blood or mucus on the examining finger. The scrotal swelling was a fairly tense right hydrocele, which could not be emptied. The apex-beat was just outside the left midclavicular line. There was a harsh systolic murmur maximal in the third left inter-space and a very loud slapping pulmonary second sound. The blood-pressure was 90/60.

He was seen to have three attacks of colic whilst in hospital, and vomited during the third attack.

It was not difficult to make a diagnosis of intestinal obstruction and the possibility of the presence of some abnormality in the development of the midgut was mentioned.

**OPERATION**—The patient was anaesthetized with cyclopropane and oxygen, using a closed-circuit machine. A right paramedian incision disclosed that the small intestine was moderately distended, but there was no excess of free fluid. The stomach seemed to occupy the midline and the great omentum hung freely from it. The cæcum was found under the left lobe of the liver,

and the rest of the large intestine occupied the left side of the peritoneal cavity. An intussusception had extended for about eight inches, nearly as far as the beginning of the sigmoid colon. This was easily reduced and was of the ileocolic type. The bowel was healthy except

Recovery was only delayed by a mild right parotitis, and the patient has remained well since. The hydrocele had disappeared by a week after operation.

INVESTIGATIONS—Section of the gland removed showed no abnormality. Subsequent radiographs show



FIG 127—Barium meal showing position of stomach and jejunum



FIG 128—Barium meal at 4 1/2 hours. The ileocaecal junction is shown to the left of the fourth lumbar vertebra



FIG 129—Heart showing enlargement, diminished prominence and concavity of the pulmonary artery, and projection to the right of the aorta

for the usual oedema of the apex, and no tumour could be felt. The ileocaecal glands were about half an inch each in diameter, and one was removed for section. No attempt was made to fix the mobile large bowel, and the appendix was not removed. The wound was closed in layers and the patient sent back to the ward in a good condition.

the salient features of complete failure of rotation of the midgut with a reversal of the position of the stomach, and also the typical picture of the tetralogy of Fallot (Figs 127-129). The haemoglobin was 130 per cent and the red cells 8,130,000 per c mm.

## DISCUSSION

The presence of multiple congenital abnormalities needs no comment. As far as can be ascertained there is no previous report of a primary intussusception occurring in a case of malposition of the midgut.

In infancy the ileocaecal angle is usually mobile, and it is obvious that, to allow an intussusception to advance far, this mobility must be very great or the mesentery of the terminal ileum must be extremely long. Stretching of the mesentery can play little part. The degree of lack of fixation of the ascending colon is not usually appreciated at operation as the bowel should not be withdrawn from the wound, except perhaps to inspect the intussusceptum, to confirm complete reduction, or possibly to deal with gangrenous bowel. But even after only partial reduction it is often evident that the whole intussusception could be lifted out of the wound, even though distended large bowel takes up its mesentery and tends to become less mobile.

A hypermobile ascending colon cannot, of course, be in any way the cause of an intussusception, but it is suggested that it is a factor which allows it to occur. The generally accepted theory that swelling of the lymphatic tissue in the terminal ileum and ileocaecal region acts in the same way as a tumour projecting into the lumen of the bowel (Perrin and Lindsay, 1921) agrees with the usual finding of

enlarged ileocaecal lymphatic glands such as were present in this case, and noted by Atkinson and Wakeley (1938). Whether the original cause of the lymphatic enlargement is infective or dietetic is so far undecided. The rarity of primary intussusception after the age of eighteen months suggests that some special factor acts in infancy and not in later life, when it is still fairly common to find a mobile caecum and ascending colon.

A hypermobile ascending colon may be regarded as failure of completion of the third stage of rotation of the midgut, and a case can be made out for suggesting that primary intussusception may be a complication of this abnormality. In this particular patient a gross degree of mobility of the bowel allowed an intussusception to occur at an unusual age.

## SUMMARY

1 A case is described in which a primary intussusception was associated with non-rotation of the midgut, congenital hydrocele, and congenital heart disease.

2 It is suggested that failure of fixation of the midgut in the third stage of rotation may be a factor in allowing an intussusception to occur.

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## ACUTE MILIARY ACTINOMYCOSIS FOLLOWING PERFORATED GASTRIC ULCER

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### CASE REPORT

E. M., MALE, aged 26, a fishmonger, was admitted drunk to the Middlesex Hospital in the early hours of June 24, 1934, with a perforated gastric ulcer.

**OPERATION**—General anaesthetic, perforation sutured, stab drain into the pelvis, incision closed. Uneventful convalescence.

Readmitted Oct. 1, complaining of abdominal pain and that his bowel had not acted for seven days. There was tenderness in the lower abdomen and the right iliac fossa. Rectal examination revealed a large firm mass in the pouch of Douglas, bulging into the rectum.

**SECOND OPERATION**—The abdomen was reopened through a median subumbilical incision and dense masses of adhesions were found which involved small bowel, rectum, and bladder, and obliterated the pouch of Douglas. Such was the induration of the mass felt in the rectum on examination and also when the abdomen was opened, that it was thought that an abdominal swab had been left in at the time of the first operation. No such foreign body was forthcoming.

Self-closing caecostomy was performed to relieve the intestinal obstruction.

The possibility of actinomycosis was also considered at this second operation, when it was clearly demonstrated that no foreign body was present. The patient was forthwith put on increasing doses of iodide of potassium and the mass in the pelvis gradually decreased in size under this treatment. Wassermann reaction and Casson's test were both negative.

Two years later—Oct. 5, 1936—a mass appeared in the upper part of the abdomen, apparently in the neighbourhood of the liver.

**OPERATION**—The abdomen was opened over the mass and an abscess in the substance of the liver was evacuated. The pus contained a small mycelium possessing the characters of the *Streptothrix actinomyces*. Potassium iodide was continued in doses of 70 gr. three times a day. Any attempt to increase the dosage was followed by symptoms of iodism.

The tentative diagnosis of actinomycosis at the second operation derived further support from the local amelioration of the pelvic condition under iodine therapy and was now fully confirmed by the discovery of the organism in the liver pus.

The mass in the hepatic area gradually disappeared, but the thickening in the pelvis was still palpable although of much smaller dimensions. There was no difficulty in bowel evacuation and the caecostomy had long since closed.

Following the evacuation of the actinomycotic abscess of his liver, the patient was able to resume his employment, performing a full day's work. He remained well for fifteen months, when he suddenly developed a cough. A fortnight before his final admission to hospital he had a haemoptysis, and a week later began to experience some abdominal pain and noticed that his belly swelled. His appetite disappeared and he lost weight rapidly in the last week or two before admission.

**RE-ADMISSION** (Feb. 16, 1938)—Pulse-rate ranged above 120. Temperature remained normal, but towards the end there was an evening rise. Râles were audible at the bases of both lungs.

Paracentesis of the abdomen led to the withdrawal of 4 pints of yellowish fluid and had to be repeated before death. The fluid contained a few epithelial cells, red blood-cells and an excess of polymorphonuclear white cells.

**Sputum examination** showed the presence of *Streptothrix actinomyces* in moderate amount. No tubercle bacilli were found.

**Blood-count**—

Hæmoglobin 65 per cent. R B C 3,900,000

W B C—

Neutrophils, 86 per cent

Lymphocytes, 8 per cent

Monocytes, 6 per cent

**X-ray Examination of Chest**—Diffuse mottling throughout both lungs, with thickening of the diaphragmatic pleura (Fig. 130). The root shadows were not increased in density, there was no pulmonary cavitation or calcification. Appearances were consistent with the diagnosis of mycotic disease of the lungs.

Despite the exhibition of potassium iodide and the intravenous injection of colloidal iodine, the patient's condition rapidly deteriorated. Haematemesis reduced his strength further, the ankles became swollen, coma supervened, and he succumbed on March 2, 1938, a fortnight after his admission to hospital and about a month from the commencement of the symptoms which ushered in the hurricane finale to his malady.



POST-MORTEM EXAMINATION—Abstract from Bland-Sutton Institute Report, 42/38

The body was that of an emaciated man with a fistula in the caecal region and a healed median laparotomy scar

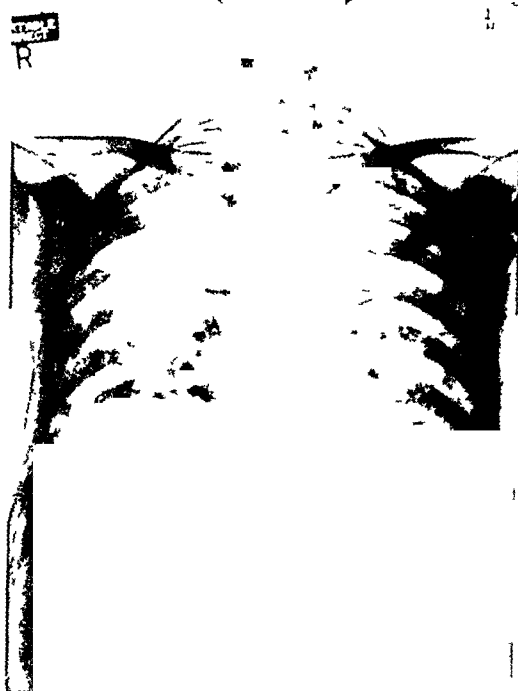


FIG 130—Radiograph of the chest, showing diffuse mottling throughout both lungs due to the miliary spread of the disease. On radiological grounds it may be impossible to distinguish this condition from miliary tuberculosis of the lungs

A small quantity of fluid was found in each pleural cavity, there were adhesions over the diaphragmatic surface of each lung. The pleural surfaces of both lungs were studded with small, firm deposits resembling the miliary



FIG 131—Section through the lung showing the small pale miliary abscesses scattered throughout its substance

spread of tuberculosis. On section of each lung, the whole cut surface was also dotted with multiple small firm nodules, which on pressure exuded yellow pus (Fig 131)

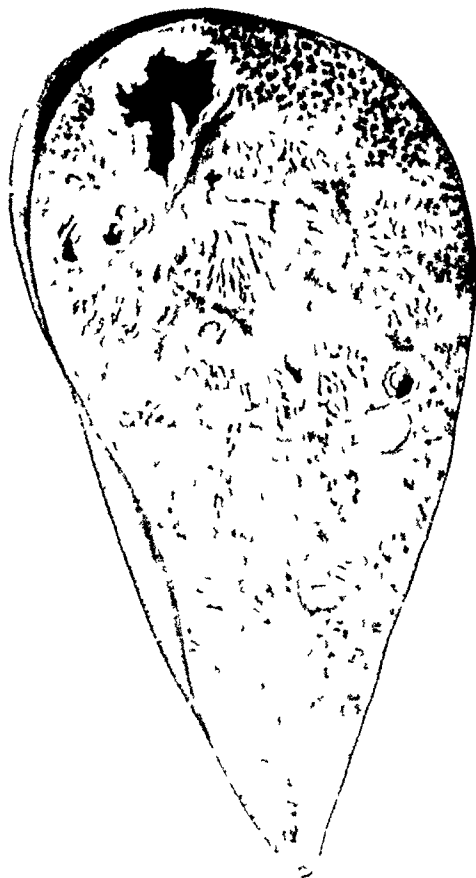


FIG 132—Section through the right lobe of the liver, showing actinomycotic abscesses with characteristic loculated arrangement



FIG 133—Section through the spleen showing actinomycotic abscesses

The abdomen contained 5 pints of yellowish fluid, the coils of small intestine were quite free, there were four small yellow granular deposits in the wall of the jejunum a few feet from its commencement. The ileo-caecal region exhibited no pathological change, there was no longer any evidence of actinomycosis in the sigmoid region, which was curved sharply on itself and fixed by adhesions. Although the transverse colon was free, there were dense adhesions implicating stomach, spleen, and splenic flexure on the left, and binding stomach, liver, and hepatic flexure on the right side of the abdomen.

The liver was honeycombed with abscesses and displayed the characteristic naked-eye appearance of actinomycosis (Fig 132). The streptothrix was obtained from these lesions. The abscesses presented on the anterior surface of the right lobe and also on the superior surface, whence pus tracked upwards through the diaphragm. On the left side of the abdomen there were gross perisplenic adhesions encapsulating a small quantity of pus below the diaphragm.

The spleen (Fig 133) and kidneys also showed milary lesions, from which the organism was obtained.

The right suprarenal capsule showed a few small granular deposits in the cortex.

### DISCUSSION

The generalized form of actinomycosis has been reported in the literature in a number of instances, but is still sufficiently rare to warrant the publication of another case. This patient was also remarkable in that the onset of the disease followed the perforation of a gastric ulcer, and that he survived the drainage of a hepatic abscess for fifteen months before the terminal hæmatogenous spread of the disease.

In 1925 Sanford and Voelker reviewed 670 cases of actinomycosis in the United States, and of these there were only 13 cases of the generalized disease. In the same year Werthemann (1925) collected 10 cases from the German literature and added two of his own. Further individual cases have been reported by Becker (1934), 2, Shapiro (1921), 1, Kasper and Pinner (1930), 1, Freed and Light (1932), 1, Fellingner and Salzer (1932), 1, Dixon (1939), 1, Parker (1923), 1, and others. Biggart (1934) has also described a case of the generalized disease due to the aerobic non-acid-fast strain classified by Topley and Wilson (1929) as *Actinomyces graminis*, in distinction from the anaerobic *Actinomyces bovis*, which is the generally accepted pathogen in man. Bates (1933) has collected post-mortem reports from the London Hospital of 6 cases of actinomycosis which succumbed as a result of hæmatogenous spread.

It is said that the pathogenic anaerobic organism may be resident in the mouth and around carious teeth, but, nevertheless, actinomycosis following perforation of an ulcer is exceedingly rare, though

one might suppose that such a perforation would provide a ready portal of entry to the peritoneum. Possibly the high gastric acidity in these cases would destroy the streptothrix in most cases. Three cases only of this complication of perforation have been found in the literature, two by Cope (1938), of which the present case is one, and one by Bates (1933) in which an actinomycotic abscess developed in the left iliac fossa after perforation of a duodenal ulcer. This present case has been reported by Cope in his book on actinomycosis as a rare example of recovery after drainage of an actinomycotic abscess of the liver, but the subsequent history of the patient after this book was published confirms Cope's opinion that hepatic actinomycosis is almost invariably fatal.

A most uncommon exception has, however, been recorded by Chitty (1944) in which the patient was alive and well 15 years after operation on an actinomycotic mass in the liver which was as large as two fists and producing jaundice.

Death from actinomycosis may be due to destruction of vital structures with or without gross secondary infection, to hæmatogenous spread, or to amyloid disease. It seems probable, as pointed out by Bates and as shown by the eventual history of this case, that death from generalized actinomycosis is possibly not so rare as it appears, but that owing to the chronicity of the disease many patients may leave hospital before the fatal termination by milary spread.

I wish to express my thanks to Surgeon Rear-Admiral G. Gordon Taylor for permission to publish this case, which was treated under his care in the Middlesex Hospital, and to Dr H. Graham Hodgson for the radiograph of the patient's chest.

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## A CONGENITAL MELANOMA OF LIP WITH CYSTIC DEGENERATION

By HOWARD REED

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### CASE REPORT

AN African boy about ten years of age was brought to me in October, 1944, when I was stationed at Mwanza. His father told me that he was born with a large swelling

of the upper lip which grew slowly until about one year ago, when it began to increase in size more rapidly.

The little fellow was exceedingly conscious of his peculiar appearance and was very sensitive about his nickname of 'tembo', the Kiswahili word for elephant.

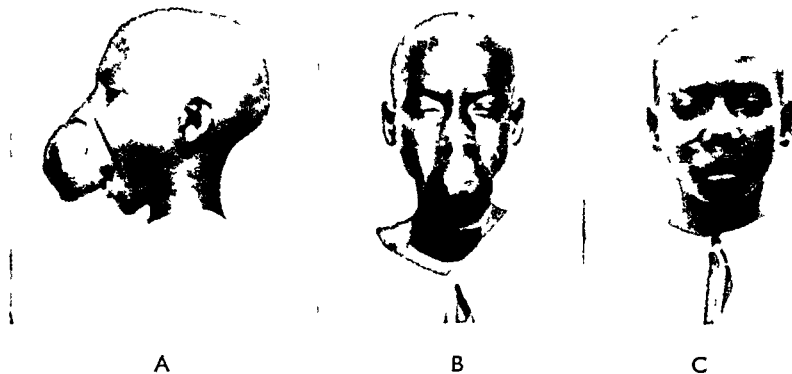
His appearance can be judged from the snapshots I took before operation (*Fig 134, A, B*). His nose merged into the upper surface of a swelling the size of a large grape-fruit, which replaced his upper lip. This swelling overhung his mouth, lower lip, and chin, and rendered his speech indistinct. When he was eating he liked to creep into a corner so that he could not be seen lifting the lump in order to slip the food into his mouth. The upper incisors, instead of forming an arc with the other teeth, were curved inwards, thus testifying to the pressure that was present during the growth of the second dentition.

**OPERATION**—Intravenous cyclonal was given by my Indian Assistant, Dr P V Gokhale, and the lump was

open, I received a squirt of Indian-ink-like fluid. I sent the specimen to Dr F W Vint, of the Medical Research Laboratory, Nairobi, who very kindly examined it and reported as follows—

"The tumour is undoubtedly a melanoma. Microscopically there is no evidence of true cyst formation, but there is cystic degeneration. The pigment is so dense that it is impossible to see the details of the cells involved and it has diffused into the surrounding fibrous tissue. It is impossible to form any opinion of the degree of malignancy, and cystic degeneration is not uncommon in these tumours in the African."

Full details were taken of the boy's village, headman, and chief, and the boy's father, on receiving reprints of



**FIG 134**—A, B, Photographs of patient prior to operation, showing the size of the tumour. C, Photograph of patient after removal of the tumour.

removed. It was found to be melanomatous and it spread down to both the nasal septum and the maxilla, but did not involve either. When the whole of the lump had been excised the gap was filled in by excising wedges of tissue on each side of the nose and cutting through the cheek at the angles of the mouth and then approximating the two resulting flaps to form the upper lip.

**PROGRESS**—The boy was fed on native porridge for the first few days after the operation and the mouth and the buccal aspect of the wound were irrigated with a gentle stream of potassium permanganate lotion to remove food debris. The wound healed quite readily and the photograph shown in *Fig 134, C* was taken three weeks after operation.

**THE SPECIMEN**—I had been surprised at operation to find that the tumour was a melanoma and was still more surprised after operation, when, on cutting the lump

the photographs, promised most faithfully that he would bring the boy for inspection after six months. When, however, in June, 1945, Dr A G Farr, the Medical Officer then in Mwanza, attempted to get in touch with the boy, the chief reported that he and his father had been away from the village for some months and no one knew of their whereabouts. I regret that I am therefore unable to say with certainty that there has been no recurrence, but in view of the congenital nature of the tumour and the fact that a year has now passed and the boy has not returned to hospital for further treatment, as he most certainly would have done had the growth recurred, I think it may be assumed that the tumour was probably a benign melanoma. The more rapid increase in size during the few months before I saw him was probably due to cystic degeneration.

## ACUTE DIAPHRAGMATIC HERNIA ASSOCIATED WITH INTESTINAL OBSTRUCTION

By I M ORR

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IN the very extensive literature on the subject of diaphragmatic hernia much attention has been paid to the chronic types of hernia, particularly to those of the para-oesophageal type, and it would seem that the condition is by no means rare. Harrington (1939) reports a personal experience of 210 cases and describes the aetiology, symptomatology, and X-ray diagnosis. He describes also the complications met with such as hæmorrhage and peptic ulceration.

There are numerous reports in the literature of diaphragmatic hernia of traumatic origin and the experience of the war will add greatly to the number. Cameron (1939) describes a case occurring thirty-two years after an old injury, and Swiney (1942) a case of acute herniation of the stomach through the diaphragm immediately following a stab wound of the chest. Laws (1944) reports a traumatic rupture through the right side of the diaphragm, which is

unusual, and Harper (1942) reports a case of left-sided traumatic rupture where the mediastinal pleura was completely torn and both sides of the chest were thus opened, recovery followed operation.

There are only a few references to strangulation of the herniated viscera. Deaner (1943) reports a case where the stomach and omentum had herniated through a para-oesophageal hiatus and had become strangulated. There was an associated hemothorax.

The most comprehensive classification of the various types of diaphragmatic hernia is given by Dunhill (1939). He divides the cases into —

a Herniation due to a congenitally short oesophagus

b Oesophageal hiatus hernia

c Hernia through a developmental communication between the abdominal and pleural cavities

d Hernia through the foramen of Morgagni

e Hernia through the musculature of the diaphragm, possibly due to sneezing or coughing

The influence of increased intra-abdominal pressure has been stressed by Ude and Rigler (1929), who noticed that diaphragmatic hernia was more common among women, especially those who had born children or suffered from ascitis or a large intra-abdominal tumour or cyst.

Rigler and Eneboe (1935) examined a series of 195 pregnant women and found that 18.1 per cent had some degree of herniation through the diaphragm.

The case about to be recorded is of interest in that it appears to have been precipitated by increased pressure due to acute intestinal obstruction, a congenital defect being present.

### CASE REPORT

On Jan 17, 1938, a young woman aged 19, was admitted to the Haslemere and District Hospital with all the signs and symptoms of peritonitis. At operation a perforated appendix was found with free pus in the peritoneal cavity. The appendix was removed and the abdomen drained. The patient recovered and kept well till Jan 27, 1944, when she was readmitted with an attack of acute abdominal pain and vomiting. The abdomen was slightly distended, but the scar of the old drainage tube in the left iliac fossa was markedly retracted. The abdomen was opened through a left paramedian incision and an adhesion causing obstruction was divided. The patient made a good recovery and remained well till Feb 21, 1945, though she complained occasionally of a feeling of discomfort round the left lower ribs.

On Feb 21, she was awakened by severe abdominal pain, most marked on the left side. The pain radiated round the left lower ribs and was referred to the left shoulder tip. The abdomen was not distended, but was slightly tender on the left side. There was nausea but no vomiting.

ON EXAMINATION — The left chest was tympanitic on percussion and gurgling sounds were heard in this region but no breath sounds. There was marked dyspnoea and the trachea was pushed to the right. The pulse was 84, and the respirations 24, temperature normal.

X-ray examination of the abdomen showed dilated coils of small intestine in the left hypochondrium. Radiography of the chest (Fig 135) revealed a pneumothorax on the left side with complete collapse of the lung, and fluid levels at the base. The outline of the left dome of the diaphragm was blurred.

Later the same day, as nausea became worse, a Ryle's tube was passed into the stomach and 40 oz of fluid were aspirated. A second radiograph of the chest

was made with the tube in situ, and it was seen to enter the pleural cavity. A diagnosis of acute diaphragmatic hernia was made and the patient prepared for operation.

OPERATION — Paravertebral block anaesthesia supplemented by positive pressure gas and oxygen was employed. The left 8th rib was resected, the pleural cavity opened, and the ribs widely spread. The left pleural cavity was completely filled with the grossly distended stomach and

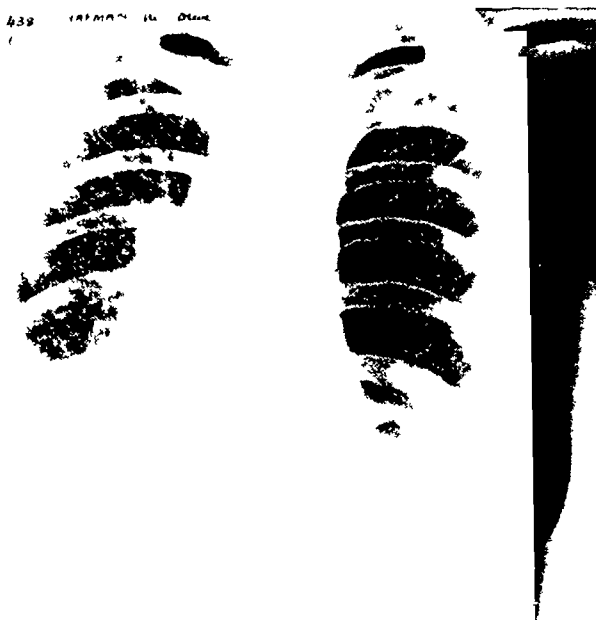


FIG 135 — Condition of lung on first admission. Left lung completely collapsed. Pneumothorax would be diagnosed but for the presence of the Ryle's tube in the thoracic cavity. The mediastinum is displaced to the right.

transverse colon. Air was evacuated from the stomach, and the deflated viscus and colon were then, not without difficulty, returned to the abdomen.

The opening in the diaphragm was  $2\frac{1}{2}$  in long and  $1\frac{1}{2}$  in wide, and was situated in the left dome between the attachments of the costal and vertebral portions. There was no peritoneal sac.

The edges of the diaphragm were approximated with chromic catgut interrupted sutures reinforced with a floss silk running suture. The left phrenic nerve was found and crushed, causing an immediate paralysis of the left dome of the diaphragm.

The chest wound was closed in layers, a small water-sealed drain having been placed in the 9th interspace in the paravertebral gutter.

Post-operative recovery was uneventful so far as the lung was concerned. It expanded rapidly, the pleural air being expelled through the water-sealed tube.

The day following the pleural operation, however, the abdomen was seen to be distended, vomiting was present and the picture was one of high intestinal obstruction. In view of the lung operation, however, efforts were persisted in to maintain the patient's condition by gastric aspiration combined with intravenous therapy.

SECOND OPERATION — On Feb 26, that is three days after the pleural operation, an operation for the relief of the intestinal obstruction became imperative and

through a left paramedian incision the abdomen was explored. The gut was adherent, some coils being collapsed and some congested and distended. During the process of freeing adhesions and attempting to relieve the obstruction a sudden leak of faecal matter appeared. This was aspirated and the leak closed with interrupted sutures. Further attempts to free adhesions were abandoned and an entero-anastomosis performed between the bowel above and the bowel below the obstruction. Sulphanilamide powder was dusted into the abdominal

The following day the shoulder-tip pain was severe, but the respiration was not embarrassed. There was nausea and a feeling of fullness in the stomach relieved by belching. The following morning the patient was in great distress. The pain was now in the left side of the thorax, the pulse-rate was 96 and of poor quality. The face was pale and the nausea and retching severe. As the day progressed the condition deteriorated. The apex beat became impalpable and the trachea was displaced to the right.



FIG 136—During convalescence from first and second operations shoulder-tip pain suggests a recurrence of the hernia and barium meal shows a portion of the fundus of the stomach herniated through the diaphragm.



FIG 137—Condition on second occasion of acute herniation. The mediastinum is displaced to the right. The fundus of the stomach extends to the 7th rib and there is a fluid level in the stomach. Later the same day the stomach and colon came to occupy the whole of the left side of the thorax.

cavity and the abdomen closed with a drain to the site of the repaired leak.

The drainage was free from the outset and later a faecal fistula developed. The general condition rapidly improved, and by the fifth day the bowels acted naturally. The fistula was troublesome, however, it healed and broke down on several occasions.

A month later a radiograph of the chest showed the lung completely re-expanded. The left dome of the diaphragm was still high. During convalescence the patient repeatedly complained of pain around the left ribs and sometimes of left shoulder-tip pain. She stated that this was the type of pain she had had for several years and that it had become more severe just before her admission.

Suspecting a recurrence of her hernia, a barium meal was given on April 4, and a small portion of the fundus of the stomach was seen to be herniated through the left dome of the diaphragm.

There was no evidence of intestinal obstruction. As the patient was averse to further operative interference and suffered very little inconvenience, she was discharged from hospital and, apart from occasional leakages from the faecal fistula, lived a normal life for three months. As time went on, however, the shoulder-tip pain became worse and she had to sleep in Fowler's position to obtain relief.

**THIRD OPERATION**—On July 3, the patient was readmitted to hospital for closure of the fistula. The operation was uneventful, except that the patient strained and coughed badly under the anaesthetic.

Radiography of the chest (Fig 137) showed marked mediastinal shift to the right. The fundus of the stomach was seen above the diaphragm with a well-marked fluid level. The left lung appeared to be compressed, but not collapsed. Attempts to pass a stomach tube into the stomach failed.

**FOURTH OPERATION**—Operation for reduction of the hernia became imperative. Paravertebral block and positive-pressure gas and oxygen anaesthesia was again employed and the pleura opened through the old scar.

The pleural sac was completely filled with stomach, colon, and omentum. The stomach was greatly distended with dark brown fluid which had to be evacuated with a sucker and cannula before any attempt at reduction could be made. As soon as the stomach collapsed the rent was inspected. It was at the same site as the former hernia, but was smaller in size. There was no peritoneal sac, but the edges of the hernia were covered with a serous membrane. The viscera were returned to the abdomen not without difficulty and the edges of the rent overlapped with mattress sutures. Floss silk was then employed to interlace the scar area completely.

The left lung was completely collapsed, but at one point it was adherent to the old scar. The adhesion was divided. A water-seal drain was introduced through a

stab puncture in the 9th interspace and the thoracic wound sutured. Considerable quantities of air were bubbled through the water-seal and aspiration of the chest was carried out to promote re-expansion of the lung.

The following day the patient was much better, though she had a slight cough and hæmoptosis.

On July 7 X-ray examination showed that in spite of aspiration the mediastinum was still displaced to the right and there was complete pneumothorax. The patient's general condition improved daily and aspiration of air was persevered with.

On July 18, X-ray examination showed less displacement and some re-expansion of the lung. A fluid level was seen at the base.

On July 26, X-ray examination showed the mediastinum restored to its normal position, but the lung had not expanded completely and two fluid levels could be discerned, apparently due to a plastic pleurisy. Barium given in the supine position showed the fundus of the stomach in its normal position below the diaphragm and no tendency to herniation.

The patient steadily improved and the temperature, which had been raised during the first fifteen days, returned to normal. On Jan 9, the patient was well and free from pain and attended the out-patient department for breathing exercises to mobilize the left side of the chest.

Radiography showed lung fully expanded and complete absence of fluid level.

### DISCUSSION

This case is of especial interest, showing as it does the part increased intra-abdominal pressure may play in inducing diaphragmatic hernia. It seems most probable in this case that there was a congenital weakness of the diaphragm and possibly a small hernia of many years' standing. This is the more likely as the patient admits that left shoulder-tip pain and pain around the lower left ribs were often experienced in the years between her original appendix operation and the onset of acute obstruction.

Following the first pleural operation, the early recurrence of a small hernia of the fundus of the stomach might have been due to faulty technique in the suturing of the diaphragm, but no doubt the increasing distension of the intestines due to

obstruction put an unusual strain on the recently sutured diaphragmatic hernia before the processes of repair had had time to develop. Furthermore, during the operation for closure of the faecal fistula the straining under the anæsthetic was sufficient to precipitate a complete prolapse of the viscera.

In discussing the operative procedure, it may be argued that an operation to relieve obstruction should have been undertaken before attempting to deal with the hernia, but it must be remembered that the symptoms of the pleural condition completely overshadowed the abdominal lesion.

Further, it might be argued that when a small portion of the fundus of the stomach was seen to have herniated after the first pleural operation it ought to have been repaired forthwith. No doubt it should, but as a small herniation is a common condition causing little inconvenience it seemed reasonable to assume that this small herniation would give no further trouble.

### SUMMARY

- 1 The incidence and classification of diaphragmatic hernia is discussed.
- 2 Reference is made to the part increased intra-abdominal pressure plays in precipitating hernia.
- 3 A case of acute herniation associated with acute intestinal obstruction is described and the operative procedure and complications outlined.

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## CONGENITAL FUSION OF LUNATE AND TRIQUETRUM

By J F CURR

TEMPORARY ASSISTANT SURGEON, ROYAL INFIRMARY, EDINBURGH, AND LEITH HOSPITAL

Two examples of this congenital abnormality were seen by me in the Royal Infirmary, Edinburgh, in 1944. The first patient, a woman aged 63, attended on account of a needle which had become embedded in the left hand and which was subsequently removed (*Fig 138*). The second patient, a man aged 35, had received a slight injury to the right wrist no fracture being present (*Fig 139*). In both cases X-ray examination showed, on one side only, a complete fusion of the lunate and triquetrum, which was obviously a congenital abnormality and was not due to any acquired cause. At no time had there been any reason to suspect that the wrists were anything but normal, and the discovery of the abnormality was purely accidental.

This condition of congenital fusion of the lunate and triquetrum is undoubtedly very rare and is of

little real importance as it does not interfere with the external appearance or function of the wrist. McGoe (1943) was unable to find a previous reference to the anomaly when he reported a unique case of a fracture of the triquetral part of the fused bone along with a dislocation of the carpus, an excellent result was obtained after reduction of the dislocation. White (1944) recorded the anomaly of fusion of the capitate and hamate, the X-ray appearances being similar to the present cases.

I am indebted to Dr R McWhirter for the radiological examinations.

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FIG 138—Fusion of lunate and triquetrum, also needle in hand



FIG 139—Fusion of lunate and triquetrum

## A CASE OF CHRONIC BILATERAL SUBPHRENIC ABSCESES

BY SURGEON LIEUTENANT H. H. BENTALL, R. N. V. R.

THIS case shows an unusual and perhaps unique complication of acute appendicitis—the development of chronic bilateral subphrenic abscesses with extension of that on the left into the pleural cavity

### CASE REPORT

*April 6, 1944* While serving overseas, an able seaman, aged 32, was admitted to hospital with acute appendicitis of two days' duration. At immediate operation a moderate amount of purulent exudate was found in the right paracolic gutter and a ruptured gangrenous appendix was removed. The post-operative course was stormy. He was nursed in Fowler's position for the whole of this time. After one month symptoms of left-sided pleurisy developed, with radiological evidence of a small basal effusion. A radiograph two weeks later was said to show "some residual reaction at the left base". On discharge early in June his temperature had been normal for two weeks and he had no specific complaints.

After a period of convalescence he served at sea until—

*Oct. 28* He fell down a ladder in heavy weather. There was no severe injury, but next day he complained of pain in the left side of the chest on deep breathing and began to have a dry cough.

Two days later he was admitted to hospital, obviously ill, with a swinging temperature up to  $103^{\circ}\text{F}$ , and raised pulse and respiration rates. There was tenderness over the lower ribs both in front and behind and evidence of left-sided pleurisy with effusion. No physical signs were noted in the abdomen and the appendix scar was said to be sound. Radiography showed a basal effusion up to the level of the neck of the fifth rib. There was no evidence of fractured ribs. The white-cell count was 18,000. Aspiration revealed "a heavily blood-stained fluid, flecked with pus and of foul odour". The Gram film showed "pneumococci and short-chain streptococci". The result of culture was not stated. The

condition was thought to be one of infected traumatic hemothorax.

Aspiration was carried out frequently in the succeeding three weeks, during which time the fever and leucocytosis continued.

*Nov. 21* The resultant empyema was drained by rib resection. The patient's condition slowly improved and the cavity became steadily smaller.

*March 14, 1945* He next complained of discomfort in the right iliac fossa. After three days a tender mass became palpable deep to the healed (McBurney) scar of the appendicectomy. This discharged spontaneously thick pus devoid of organisms and sterile on culture.

*May 5* He was transferred to a Royal Naval Auxiliary Hospital, where he came under the care of the writer. He was an ill patient, thin and pale. There was no pyrexia.

A small sinus was discharging thick creamy pus at the site of rib resection. There was a small bronchopleural fistula. The sinus opening in the appendicectomy scar was also discharging thick pus.

A pleurogram (Fig 140) showed a small residual empyema cavity with a bronchopleural fistula.

The case was considered to be one of right-sided subphrenic abscess and left-sided empyema due to infected traumatic hemothorax.

### TREATMENT AND SUBSEQUENT COURSE—

*May 8* *Redrainage of Chronic Empyema* The cavity was explored but no ramifications were found after careful searching. All regenerated rib was resected and a large-bore rubber tube inserted. Vigorous breathing exercises were commenced.

*June 3* Lipiodol examination of the abdominal sinus revealed a tortuous intraperitoneal track leading from the right iliac fossa to a large cavity in the right posterior superior subphrenic space (Fig 141).

*June 5* *Drainage of Right Subphrenic Abscess* The abscess was approached extra-serously through the bed

of the twelfth rib at the level of the first lumbar spine (Ochsner and Graves, 1933). A cavity was entered and found to contain 10 oz of evil-smelling pus. Digital exploration revealed a unilocular cavity about the size of an orange. A large rubber tube was inserted around

the empyema sinus communicated with the left posterior subphrenic space, and that the elevation of the diaphragm, present to a lesser degree previously, was, in fact, due to a left subphrenic abscess and not to retraction following the healing of the empyema.

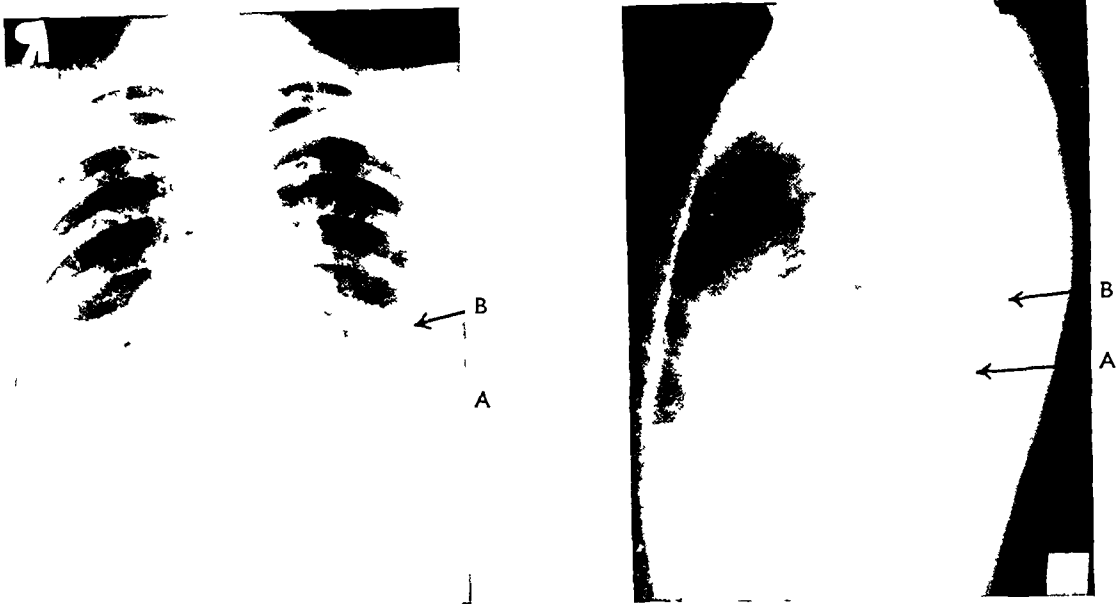


FIG 140—Anterior-posterior and left lateral pleurograms showing small residual empyema cavity with a broncho-pleural fistula. A, Skin marker at sinus, B, Extent of empyema cavity.

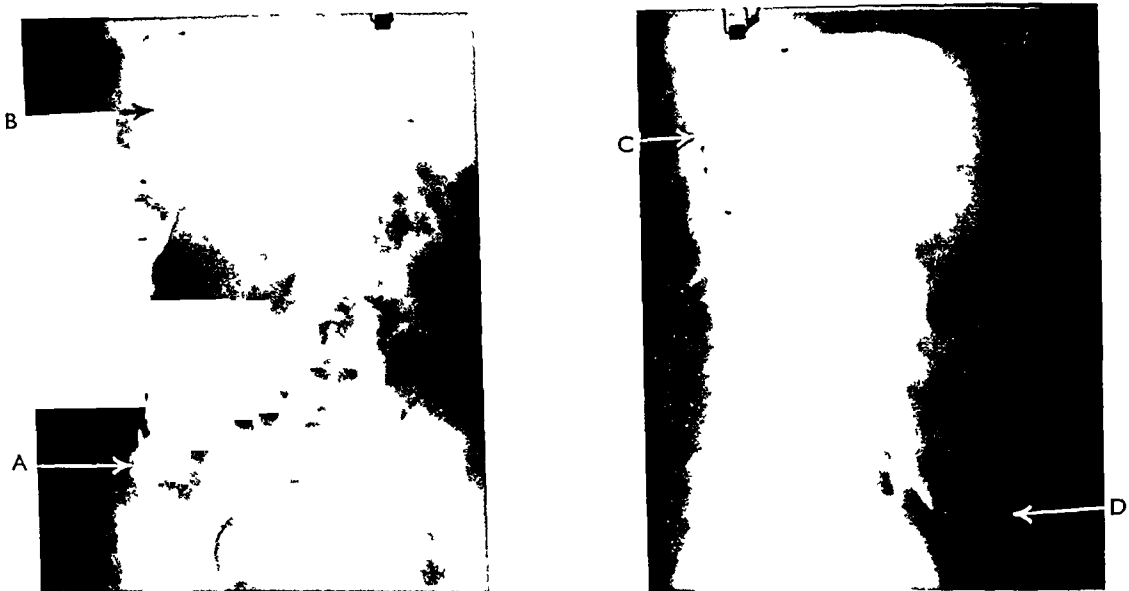


FIG 141—Postero-anterior and right lateral radiographs showing track from abdominal sinus to right subphrenic space. A, Marker on skin sinus, B, Lipiodol in right subphrenic space, C, Abscess cavity, D, Opening of sinus on to skin.

which the wound was closed. Two days later discharge from the abdominal sinus ceased and has not since recurred. Progress was rapid and the patient soon became ambulant.

*Aug 23* The empyema wound, which had been healed for a month, began to discharge and tenderness was present over the left twelfth rib. A further lipiodol examination was performed (Fig 142). This showed that

*Aug 27 Drainage of Left Subphrenic Abscess* The outer half of the eleventh rib was resected. The adherent visceral and parietal pleura were separated from one another over the dome of the diaphragm until the abscess was palpable. The cavity was opened, its wall being at least  $\frac{1}{2}$  in thick. Digital exploration again revealed a unilocular cavity about the size of an orange. A large rubber tube was inserted and brought out through a



separate stab wound adjacent to the main incision, which was sutured

Primary healing ensued The chest wall sinus from the empyema ceased to discharge immediately and soon closed

**PATHOLOGICAL INVESTIGATIONS**—From the onset of the acute empyema in October, 1944, until after drainage of the right-sided subphrenic abscess in June, 1945, there was a leucocytosis of 18,000 or more The blood-count 17 days after this operation was as follows —

Red cells, 4,000,000

Hæmoglobin, 80 per cent

Colour index, 1.0

White cells, 8400

Polymorphonuclears, 64 per cent

Lymphocytes, 30 per cent

Large monocytes, 4 per cent

## DISCUSSION

Ochsner (1938), in a review of 3583 cases of subphrenic abscess, describes three broad types of onset —

1 Those of sudden onset (14 per cent), showing symptoms in two or three days from the initial infection

2 The common type (70 per cent), showing fever and leucocytosis after 10 to 21 days

3 Those of insidious onset (16 per cent), showing, as a rule, only general symptoms such as malaise commencing after many weeks or months It is into this group that the present case falls

Discussing the aetiology of left-sided abscess Neuhof and Schlossmann (1942) have shown in an

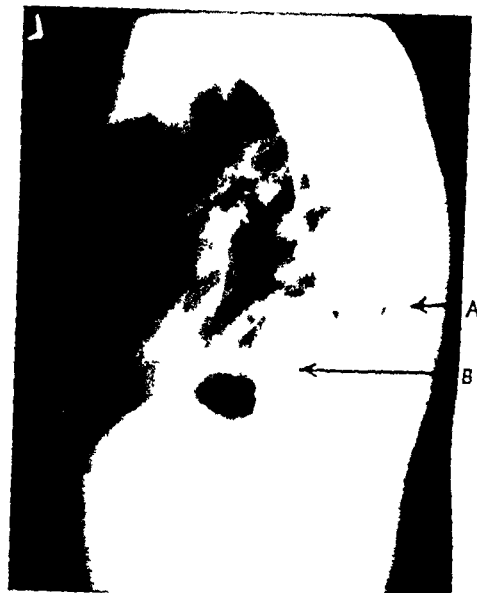
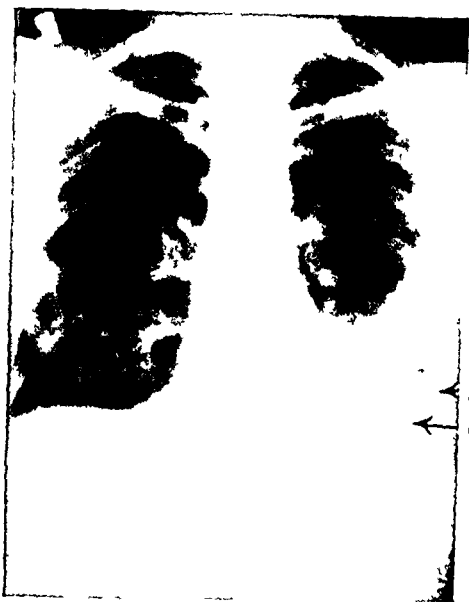


FIG 142.—Postero anterior and left lateral pleurograms showing elevation of left diaphragm and evidence of communication between left empyema sinus and left subphrenic space A, Lipiodol in empyema sinus, B, Lipiodol in subphrenic space

In August, 1945, just before drainage of the left-sided subphrenic abscess, the blood-picture was unchanged

**Bacteriology**—At the first aspiration of the empyema the stained film showed pneumococci and short-chain streptococci There is unfortunately no record of the result of culture at this time Subsequent examinations of pus gave negative results as tabulated below

SOURCE	FILM FOR TUBERCLE BACILLI	FILM FOR ACTINOMYCES	AEROBIC AND ANAEROBIC CULTURE
Abdominal sinus	13 times	10 times	7 times
Empyema	5 times	5 times	5 times

A section of pleura taken at the time of redrainage of the empyema showed no evidence of tuberculosis, and inoculation of a guinea-pig with pus from the abdominal sinus was negative

**END-RESULT**—Obliteration of all the abscess cavities following adequate drainage was rapid The patient's general condition steadily improved and he was finally discharged from hospital in December, 1945, entirely free from symptoms

analysis of 33 cases that the source of infection is usually local rather than remote, as on the right side They report 2 cases resulting from appendicectomy and pelvic suppuration, which they ascribe to lymphatic rather than to direct intraperitoneal or retroperitoneal spread, and a further 2 cases resulting from pelvic suppuration by way of a retroperitoneal track over the sacral promontory along the psoas muscle They conclude that there are no pre-existing specific pathways of infection to the left subphrenic space, and that suppuration beneath the left diaphragm is contingent upon direct extension from regional areas in most cases

The association of empyema with subphrenic abscess is well known It is, however, relatively more common on the right side owing to the fixity of the liver On the left side, by contrast, the freely mobile stomach and spleen offer less resistance Elevation of the diaphragm, an inconstant accompaniment of subphrenic suppuration, is for the same reason more likely to occur on the right

In this case, however, the left diaphragm was markedly domed and the right showed no elevation

At all times both sides of the diaphragm moved well in a normal direction on screening

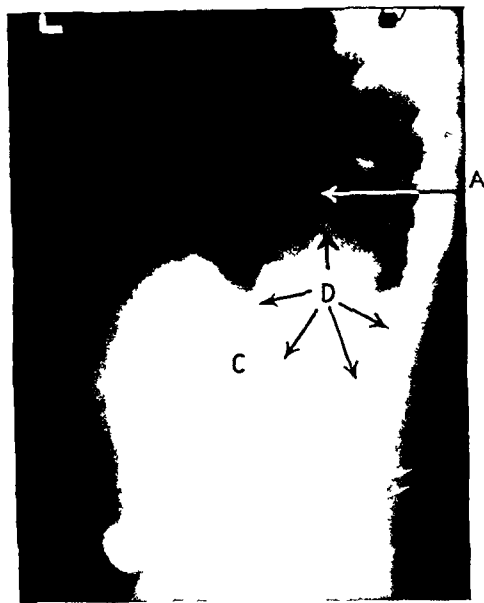


FIG 143.—Left lateral radiograph following barium meal, showing relation of abscess to stomach and colon. A Elevated left diaphragm, B, Gas in stomach, C, Gas in colon, D, Abscess

In this case the right-sided abscess was probably caused by the intraperitoneal spread of infection along the right paracolic gutter, along which route, in reverse, it later discharged. If this assumption is correct,

it seems likely that the left-sided abscess was also due to direct intraperitoneal infection, in this instance by way of Morison's pouch to the lesser sac. The close relation of the abscess to the lesser sac was confirmed by the relative positions of the stomach, abscess, and transverse colon, as seen in the left lateral film following a barium swallow (Fig 143).

It is interesting that apart from a 'stormy convalescence', the only specific symptoms referable to the subphrenic region were those of a left basal pleurisy at one month. Shoulder pain was constantly absent. Extension of the left-sided abscess into the pleural cavity appeared to be precipitated by a fall, although this might have occurred spontaneously in the course of time.

### SUMMARY

A case is described of acute appendicitis followed by chronic bilateral subphrenic abscesses and left-sided empyema thoracis. The diagnostic and operative measures employed are detailed and the aetiological factors concerned are briefly discussed.

I wish to thank the Medical Director-General of the Royal Navy and Surgeon Rear-Admiral C H M Gimlette for permission to publish this account, and Surgeon Captain J Hamilton, R N, for his help and encouragement.

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## REVIEWS AND NOTICES OF BOOKS

**L'Urographie Intra-veineuse (UIV)** By BERNARD FEY and PIERRE TRUCHOT 9 $\frac{3}{8}$  × 6 $\frac{3}{8}$  in Pp 213 + viii, with 242 illustrations 1944 Paris Masson et Cie 320 fr

WHEN the new diagnostic method of intravenous urography was first described by Von Lichtenberg and Swick in 1929, its advantages were so patent that it soon became widely adopted. Its application on a large scale has, however, been somewhat slipshod both in radiological technique and in the interpretation of the urograms, and there is no doubt that its full possibilities have not yet been exploited. The present work is a critical evaluation of the method based on and illustrated by numerous cases, and whilst it forms a useful atlas of intravenous urography, it is from the accompanying text that both the clinician and the radiologist will derive the most benefit.

Professor Fey, originally an opponent of compression for artificially increasing the radiological shadow, now comes forward as one of its most ardent advocates. He uses the delayed compression technique of Colliez, in which compression is applied after the first film of secretion has been taken and is maintained for 10 to 15 minutes. Another film is then taken immediately after decompression. Recognizing the errors which may be introduced by compression, he is convinced that they are

avoided by the film after release and he claims that the lower ureters are best demonstrated by this technique, a claim which is amply supported by the illustrations.

The authors are of the opinion that some films are radiologically valueless owing to faulty technique, whilst in some the urinary concentration is insufficient to give a shadow. In the latter group the fault is often due to lack of co-operation between the urologist and the radiologist, and to overburdening the X-ray department with three or four cases to be completed in two hours, apart from other examinations. If the investigation is to yield the fullest information it makes great demands on the time of both the clinician and the radiologist, who must be prepared to modify the times of the films according to the circumstances of the individual case. Given such collaboration the cases where one must have recourse to pyelography are few.

The results illustrated justify the care demanded and make one feel that we have not as a whole in this country made the best use of intravenous urography. An English translation of this work would fill a great gap.

Published in France in 1944, the book is well produced and on paper of excellent quality. It lacks a bibliography, and the index might well be extended, it is worthy of something stronger than a paper cover, but its perusal is well worth the two hours taken in cutting the pages.

**Hospital Care of the Surgical Patient** By GEORGE CRILE, jun, M D, Surgeon, Cleveland Clinic, and FRANKLIN L. SHIVELY, jun, M D, Assistant Surgeon, Cleveland Clinic With a Foreword by EVARTS A. GRAHAM Second edition  $8\frac{1}{2} \times 5\frac{1}{2}$  in Pp 288 and 18, with 25 illustrations 1946 Springfield, Ill C C Thomas (London Bailiere, Tindall & Cox) 14s net

THE fact that a second and enlarged edition of this book has been required within three years of its first appearance testifies to its usefulness. A book like this is of value not only for the instruction of House Officers but also because it records for the benefit of the world at large what is the practice of the Cleveland Clinic at the present time. Fashions change in surgical care as in everything else, and revisions will be needed as the years go by we may therefore look forward to many more editions in future.

It is one thing to lay down certain rules and orders with the object of standardizing hospital procedure, but here we have set out the physiological and biochemical principles upon which the authors have based their practice. The book covers a wide field in 'general' surgery, but it may be that in future editions details of the management of thoracic and cerebral cases before and after operation can be included. The true 'specialties' should perhaps still be excluded for fear of making the book too bulky and throwing it out of balance. Even now the arrangement of Section II on *Surgical Complications* seems to be rather haphazard. Most of the descriptions of the technique of treatment are clear and adequate, but it seems doubtful if the gastric suction apparatus, as illustrated, would work.

There is a useful appendix indicating how the lessons learnt during the war about the treatment of wounds can be applied to the problems of civilian surgery.

**A Manual of Surgical Anatomy** Prepared under the auspices of the Committee on Surgery of the Division of Medical Sciences of the National Research Council, by TOM JONES, Professor of Medical and Dental Illustration and Head of Department of Illustration Studios, University of Illinois Medical School, and W C SHEPARD, Art Editor, W B Saunders Co  $10\frac{1}{2} \times 8$  in Pp 195 + xvi, with 267 illustrations, 153 in colour 1945 London and Philadelphia W B Saunders Co Ltd 25s net Pocket edition also available

THIS is an atlas rather than a manual in the accepted sense of the term. It has been produced primarily to help war surgeons, but it will undoubtedly find a useful place amongst others. The illustrations are line drawings with shading, colour is used only when necessary for clarification and is never blatant. The pictures are very good, and their labelling is excellent. Standard English terminology is used, but the equivalent B N A terms are given in the comprehensive explanatory index.

We can strongly recommend this as an atlas of surgical anatomy, and its price at the present time is most reasonable.

**Principles and Practice of Surgery** By W WAYNE BABCOCK, M D, Emeritus Professor of Surgery, Temple University, Acting Consultant, Philadelphia General Hospital. With the collaboration of 37 Members of the Faculty of Temple University  $10\frac{1}{2} \times 6\frac{1}{2}$  in Pp 1331, with 1141 illustrations 1946 London Henry Kimpton 60s net

THIS is a large, comprehensive volume of some thirteen hundred pages, covering the whole realm of surgery. The author has wisely recognized the weakness of single authorship and has made use of thirty-seven collaborators drawn from the special departments of the Temple

University. There is surprisingly little overlapping of chapters and this is probably due to the able editorship of Professor Babcock, who is known the world over for his well-known *Textbook of Surgery*.

The illustrations, which number 1141, are excellent and for the most part are original and stimulating. There has been, in the past, too great a tendency for authors to make use of dated pictures and drawings and to borrow blocks from other text-books. It is refreshing, therefore, to find such wealth of new, original illustrations in this volume.

During the second World War surgical treatment received a very definite stimulus, and trial of new methods on a large scale was available. The outcome of this can be seen in the remarkable results obtained from penicillin in syphilis, gonorrhoea, and streptococcal and staphylococcal infections. These new methods of treatment are well described in this book.

The lay-out of the contents of this volume is rather novel. Part 1 deals with general surgery and is very well presented. Part 2 is devoted to surgical technique, which includes infection and disinfection, surgical therapeutics, bandaging, anaesthesia, pre- and post-operative treatment, plastic surgery, ligations, and amputations. Part 3 is concerned with the surgery of the systems, and Part 4 deals with regional surgery.

A most useful appendix is given at the end of the book, this gives a very full account of normal blood, its volume, viscosity, haemocrit, cells, and chemical constituents. This ready reference to facts and figures will be welcome to all surgeons who cannot carry these detailed facts in their heads.

A very comprehensive bibliography completes this useful and practical volume.

Professor Babcock is to be congratulated on his latest book, it is a real credit to himself and his co-workers at Temple University.

**Injuries and Diseases of the Oesophagus** Being the George Haliburton Hume Memorial Lectures By G GREY TURNER, Professor of Surgery in the University of London at the British Post Graduate Medical School  $8\frac{1}{2} \times 5\frac{1}{2}$  in Pp 100 + viii, with 19 illustrations and 8 plates 1946 London Cassell & Co Ltd 15s net

THESE are two lectures delivered in 1943 by Professor Grey Turner, in which he pays tribute to the memory of his teacher, George Haliburton Hume, a surgeon to the Royal Infirmary, Newcastle, who died twenty years previously.

In these two lectures Grey Turner tells much of his personal experiences in the surgery of the oesophagus, a branch of surgery which had fascinated him for many years and compelled him to think and study. He tells the story of successes and failures in a very human and anecdotal manner, which is reminiscent of those clinical demonstrations for which the Professor is a past master.

**Diseases of the Breast** By CHARLES F GESCHICATER, M A, M D, Commander, Medical Corps, U S N R, with a Special Section on Treatment in collaboration with MURRAY M COPELAND, A B, M D, F A C S, Instructor in Surgery, Johns Hopkins Medical School, etc. Second edition  $9 \times 6$  in Pp 826 + xxvi, with 593 illustrations and 3 coloured plates 1946 Philadelphia and London J B Lippincott Co 72s net

THE second edition of this well-known book has been thoroughly brought up to date in the light of recent advances in mammary conditions. The use of penicillin in the treatment of acute and chronic mastitis is well set out, and the treatment of chronic cystic mastitis by endocrine therapy is given its proper place.

The book is a useful and clear guide, covering every conceivable aspect of diseases of the breast. The illustrations are numerous and for the most part are good, but it is a pity that certain drawings have been included which are supposed to demonstrate clinical characteristics, and in that they fail miserably.

The statistical tables are very interesting and should prove of value to surgeons who wish to compare the results of treatment with other hospitals both in England and America.

**The Traumatic Deformities and Disabilities of the Upper Extremity** By ARTHUR STEINDLER, M D, F A C S, Professor and Head of the Department of Orthopaedic Surgery, the State University of Iowa, in collaboration with JOHN LOUIS MARXER, M D, Associate, Orthopaedic Department, the State University of Iowa. 10 x 6½ in. Pp 394 + xxi, with 443 illustrations. 1946. Springfield, Ill. Charles C Thomas. \$10.00.

THE writings of Arthur Steindler are well known the world over, and the present monograph contains a wealth of clinical material that has passed through his clinic at Iowa. This is an age of trauma, with the increase in accidents due to aviation and mechanical transport.

The surgeon must of necessity be much more conservative with injuries of the upper extremity, as its main function is mobility, while the lower extremity demands stability before anything else.

In this monograph every type of traumatic deformity or disability is fully considered from every aspect. The importance of a correct diagnosis is stressed and the appropriate treatment given. The reviewer is pleased to see that conservative treatment has a high place in Professor Steindler's clinic.

Numerous case reports with radiographs increase the value of this volume; they always help to convince the reader of any particular difficulties which may arise and the way these difficulties may be overcome. The illustrations throughout this book are excellent and the clinical photographs deserve special praise. Good clinical photographs taken before and after operation will give much more information than any amount of text.

The importance of occupational therapy and rehabilitation are recognized and given their proper place in the treatment of injuries of the upper extremity.

This book will prove of real value to surgeons who have to deal with traumatic conditions, and it will also serve as a book of reference on this important subject.

**The 1945 Year Book of Industrial and Orthopaedic Surgery** Edited by CHARLES F PAINTER, M D, Orthopaedic Surgeon to the Massachusetts Women's Hospital and Beth Israel Hospital, Boston. 7 x 4½ in. Pp 432, with 225 illustrations. 1946. Chicago. The Year Book Publishers Inc (London H K Lewis & Co Ltd). 18s net.

THE 1945 edition of this well-known volume contains much stimulating material, and not a little which will be regarded in this country as controversial. It is inevitable in a book of this nature that there will be articles and opinions which will not meet with universal approval, but on the whole the Editor has shown wise discrimination in the selection of contributions representative of present-day informed opinion. Though the articles extracted are predominantly American, some of the more important British contributions to this literature have been included.

During the period under review orthopaedic interest was especially concerned with the problems of arthritis, osteomyelitis, fractures, and low back pain with sciatica. These fields are all soundly covered. In the section on rheumatoid arthritis the main emphasis is on the uncertainty of results and on the dangers of toxic reactions following gold therapy. The treatment is justified,

however, by the fact that considerable relief is obtained in slightly more than half the cases treated. In discussing the treatment of acute haematogenous osteomyelitis with penicillin, the tendency is to recommend doses which in many British centres would be regarded as inadequate. The importance of early surgery in addition to chemotherapy is rightly stressed by more than one observer. The articles on fractures and other traumatic conditions are in the main sound. The omission of any reference to bone grafting by means of cancellous chips from the ilium is a little surprising. In the section on the spine it is clear from the diversity of opinions presented that the solution of the problem of sciatica and the retropulsed intervertebral disc has not yet become crystallized.

Industrial medicine is a comparatively new field, and several contributors emphasize the importance of adequate facilities for pre- and post-graduate training in the special problems involved. The notes on modern industrial hazards and occupational diseases will be of value.

Although from the title it might be thought that the industrial medicine would take up a considerable proportion of this book, this is an erroneous impression, since this section occupies only approximately one-eighth of the subject matter.

**The X-ray Treatment of Accessible Cancer** By D WALDRON SMITHERS, M B, D M R, Director of the Radiotherapy Departments, The Royal Cancer Hospital (Free), and the Royal Free Hospital, etc. 10½ x 7½ in. Pp 147 + viii, with 102 illustrations. 1946. London. Edward Arnold & Co. 40s net.

THIS is a book which is full of useful information to the surgeon, for it sets out in a very practical and lucid manner the real value of X-ray therapy in the treatment of accessible cancer.

The clinical records are excellent and it is to be hoped that all hospitals in which X-ray therapy is carried out will adopt the very thorough history sheets as advocated and used by the author. The use of clinical photographs are of real importance in assessing the value of any form of treatment, as the pre- and post-operative pictures can be compared, and in this volume full use of this form of recording has been made. Some coloured photographs have been included and are truly excellent.

The results of treatment of various forms of cancer by X rays are set out in a very practical and interesting way, and the reader cannot help being impressed with the good results obtained.

Two very useful appendices are to be found at the end of the book, one dealing with definitions and the other with isodose curves.

A very extensive and comprehensive bibliography, an author's index, and a subject index complete this useful and very readable book.

**La Faculté de Médecine de Paris Ses Origines, ses Richesses artistiques** By PIERRE VALLERY-RADOT. 8½ x 5½ in. Pp 86 + vi, with 26 illustrations on 12 plates. 1944. Paris. Masson et Cie.

THIS is a beautifully got up and well-illustrated small book giving an account of the Faculty of Medicine of Paris, together with its origins and its artistic treasures. The book is of peculiar interest to surgeons because for centuries and up till the Revolution the Faculté de Médecine and the Collège de Chirurgie were two separate institutions, each having its school, its statutes, its professors, and its students. After the Revolution the two institutions were merged into one establishment, for the time called the Ecole de Santé, later to become the Faculty of Medicine.

The record of the Collège de Chirurgie detailed in this book is of undoubted interest to students of medical history.

**The Early Diagnosis of the Acute Abdomen** By ZACHARY COPE, B A, M D, M S (Lond), F R C S (Eng), Surgeon to St Mary's Hospital, etc Ninth edition  $8\frac{1}{2} \times 5\frac{1}{2}$  in Pp 262 + xv, with 38 illustrations 1946 London Geoffrey Cumberlege, Oxford University Press 12s 6d net

THERE is always a demand for a really good thing, and the fact that this is the ninth edition speaks for itself

The seventh edition was reviewed in this JOURNAL in 1936 (April) and the eighth in 1940 (July) It must have given the author a peculiar satisfaction to have been able to write in the Preface of of this edition "I have met many Doctors from the United States of America and from all parts of the British Commonwealth who have generously expressed their indebtedness to this little book I would like to take this opportunity of letting them know how much pleasure and encouragement their testimony gave me"

The minor alterations and additions in this edition are few and have been carefully considered before inclusion by the author from his further experience

The reviewer who considered this book in 1936 quibbled with the term 'acute abdomen' He would "have vastly preferred the title to have been 'The Early Diagnosis of Acute Abdominal Crises'" If such advice had been taken then probably no subsequent edition would have yet been called for

From an academic point of view "abdominal crises" sounds well, an exact diagnosis is desirable in all cases

The busy practitioner, however, really wants what this book provides—namely, the facts and means whereby he can determine that the case is an 'acute abdomen' and to send it for surgical intervention rather than to try and unravel a crisis

With this idea in view the author rightly devotes the first fifth of the book to the principles and methods of diagnosis before considering individual conditions which may give rise to the necessity for using them He first of all stresses the history of the onset, and the previous history of the patient, and then the routine examination It is well known how difficult this may be, both for the patient in acute pain and the practitioner, called out of bed from his well-earned rest at the end of a busy and tiring day

Moreover, all vomited material and bowel discharge having been thrown away in preparation for the doctor's visit, the only diagnosis that often can be made is that of 'acute abdomen'

How well fitted to the occasion are the words, "Having eyes, see ye not? and having ears, hear ye not?" and do ye not remember

It is little wonder that if an exact diagnosis is attempted the same mistake may be made for the *n*th time

The author rightly stresses the uselessness of paying much attention to the pulse and temperature in the early stages The bradycardia of the acute abdomen, and the low temperature resulting from the initial shock which is only slowly rising has lulled to sleep the clinical acumen of many, but if the pulse-rate is rising on the second visit then it is a matter of great importance

The normal pulse-rate and temperature, together with the absence of rigidity in the early stage of an acute appendicitis in the pelvis, especially if the patient is a child, will deceive the most wary, as also will the physical signs when the patient is seen soon after the pain is relieved by rupture of the organ

The description and explanation of the symptoms and signs of acute pancreatitis are very succinctly described, and it is a pity that the terms of reference of his title preclude the author from giving or at least indicating his treatment of this condition He may possibly rely after a correct diagnosis on duodenal suction, agreeing with the writer of Ecclesiastes, that "A living dog is better than a dead lion" The use of a straight radiograph as often determining the diagnosis in acute intestinal

obstruction is rightly stressed and the illustrations of its use are most convincing

There is a short concise description of the rare condition of volvulus and the difficulties of diagnosing it from stricture of the large bowel, but no mention is made of the fact that the two conditions may be coexistent, and, in fact, when treating a case of volvulus the presence of a stricture in the distal gut should be borne in mind as a probable cause

The early diagnosis of strangulated and obstructed hernia is considered in a separate chapter from that upon acute intestinal obstruction, but it is rather difficult to agree with the statement, "It is usually a very easy matter to diagnose a strangulated hernia"—is it? The symptoms and signs making the diagnosis are those of the obstruction Strangulation is really a pathological condition, in fact, obstruction is very rarely unassociated with some degree of strangulation or interference with blood-supply, at any rate, the prognosis certainly depends upon the latter and this can only be determined at the operation Be that as it may! It might possibly be better not to use the terms more or less synonymously as is often the case The opinion that "the hernia is obstructed but not strangulated" often accounts for the fatal outcome of the case

The chapter on "The Acute Abdomen in the Tropics" is very concise and useful and will make a special appeal to many who during the recent years have been faced with the difficulties

The tables detailing the differential diagnosis of the various pathological lesions accounting for and simulating the acute abdomen are most useful and helpful

The book can be thoroughly recommended to all who in the course of their work meet the acute abdomen It should also be read by the student doing his surgical dressing He, unfortunately, usually sees the case when the diagnosis of an acute abdomen is very obvious In the course of his work in practice he meets much more commonly the 'chronic abdomen' for which at present there is little room in hospitals, and when he meets the early acute abdomen it bears little resemblance to those he saw while in hospital

To the house surgeon and those who have to unravel the crises, the book should be invaluable, a veritable *vade mecum*, but even so the adage that every acute abdomen should be opened with an open mind must never be forgotten

**Fractures of the Jaws** By ROBERT H IVY, M D, D D S, F A C S, Professor of Plastic Surgery, School of Medicine, University of Pennsylvania, etc, and LAWRENCE CURTIS, A B, M D, D D S, F A C S, Associate Professor of Plastic Surgery, School of Medicine, University of Pennsylvania Third edition, thoroughly revised  $9 \times 5\frac{1}{2}$  in Pp 174, with 220 illustrations 1946 London Henry Kimpton 22s 6d net

This well-known monograph has now reached a third edition and thoroughly deserves its continued success The last war gave a great impetus to the improved methods of treatment of jaw fractures The new and varied types of apparatus built on the Roger Anderson model have facilitated in no small way to the excellent results that now obtain in fractures of the lower jaw

This book is written in a lucid style, is comprehensive, and is practical to a degree It should prove of real value to all interested in dental and traumatic surgery The illustrations are numerous and of a high standard

**Demonstrations of Operative Surgery for Nurses** By HAMILTON BAILEY, F R C S, Surgeon, Royal Northern Hospital, London, etc  $8\frac{1}{2} \times 5\frac{1}{2}$  in Pp 348 + viii, with 531 illustrations, some in colour 1945 Edinburgh E & S Livingstone 21s net

## REVIEWS AND NOTICES OF BOOKS

'They shall not grow old, as we that are left grow old  
Age shall not weary them, nor the years condemn  
At the going down of the sun, and in the morning we will  
remember them —Laurence Binyon

This book is dedicated to the author's only child—his son—who was accidentally killed on July 29, 1943, aged 15. How many parents have suffered thus during the past six years? The sympathy of all must go out to those who have experienced such a calamity. They can only bow and accept the decrees of Providence and try to realize that "the trivial round, the common task, would furnish all we ought to ask"—but so it is, and in this *his* latest book for those who do not grow old—namely, the students—he has accepted the decree and applied himself to the endless and perpetual task of the teacher.

He vindicates the book when he says, "My critics say that I expect my nurses to know too much. I contend that if nurses understand the principles upon which this operation (and others) are founded not only will their work be interesting, but they are bound to become more skilful." Few surgeons will disagree with this. All know full well the difference between the haphazard assistance in theatre or elsewhere of the nurse who is content to remain merely a cipher and the one who, though perhaps only preparing for a manipulation, or handing an instrument, is doing each step of such procedure in her own mind. In the latter case all runs smoothly, while in the former preventable difficulties arise which may ultimately lead to chaos.

The book consists of eighty-three demonstrations of surgical procedures, the consecutive steps of each and the *raison d'être* are explained in simple language helped with beautiful illustrations. For the more specialized operations the author has availed himself of the help of twenty-four contributors, including three theatre sisters and a surgical instrument maker.

The style of the book remains conversational throughout and leaves in the mind of the reader the impression of an absence of hurry and fuss in the theatre, and a realization that the only thing that matters is the well-being of the patient.

Interest is also maintained by the brief footnotes on most every page, which give the period during which he lived, and the place where he worked, of every surgeon mentioned in connexion with an instrument, operation, or manoeuvre. If these footnotes are studied it will prevent ideas such as that *Rokitansky was one of Napoleon's cavalry generals*.

It is, however, a pity that the photograph which is the frontispiece and is also on the book jacket should have been included. It is a copy of a photograph called "Women in White", or it might be "How Not to Wear a Mask", by a leading American surgeon. It creates a bad impression, as in four out of the six women depicted, the face mask is not over the nostrils. It is to be hoped that this is merely due to haste and has now been rectified in the University of Chicago. The first demonstration is rightly that on the management usually used, with a description of how and when they are usually employed. This is followed by one on the management of the operating table, one almost wishes that this had been printed in heavy type. Demonstrations in natural sequence follow on the management of the theatre sterilizers and theatre lamp, on the care and sterilization of rubber gloves, syringes, scissors and scalpels, drainage tubes, etc.

The ritual of preparation of the surgeon for the operation follows next (there is a slight mistake in the caption below Fig 66). Then the method of administering intravenous fluids is discussed—a procedure in which the nurse can play such a helpful or devastating part. Abdominal surgery is introduced by a demonstration on the anatomy of the abdominal wall and the various incisions which can be used for a laparotomy. After this the common operations done in any large general hospital

are discussed and described. The author emphasizes "that the operations I demonstrate to you show only the method I employ", and how much better it is to know one method well than odds and ends of several. Suffice it to say that any nurse who has experienced and studied these demonstrations could always easily appreciate the variations employed in the individual technique of any operator. The book will be of the greatest value not only to nurses both during and after their period of training, but should also be studied by every medical student, and kept for reference while a house surgeon and later.

Many will criticize that much in the book is quite unnecessary for a nurse to know—theirs not to reason why—or they may say that the nurse should comfort herself with such thoughts as "they also serve who only stand and wait." This attitude is surely wrong, as is quoted in the Preface from a lecture by Evarts A. Graham, when President of the American College of Surgeons. "The fact that Florence Nightingale and Joseph Lister were contemporaries has been of the greatest importance to us." The converse is also true, how much better doctors we might be if some things were excised from the curriculum and replaced by six months in the wards as a nursing orderly, with a course of lectures and demonstrations by a good Sister tutor. Lecture demonstrations such as these can only do good and must contribute to the realization of the medical ideal—"There shall be no more death, neither sorrow nor crying, neither shall there be any more pain."

**Anatomical Atlas of Orthopaedic Operations** By L. S. MICHAELIS, M.D., Orthopaedic Surgeon, E.M.S., Member of the Orthopaedic Unit, Botleys Park War Hospital 9½ × 7½ in Pp 67, with 73 illustrations in colour 1946 London William Heinemann (Medical Books) Ltd 25s net

This book is a guide chiefly to the approaches used in operative procedures on the locomotor system, but stops short of the later stages. The less experienced surgeon, for whom this book was presumably written, will thus require to refer to a fuller account.

The many illustrations are so over simplified that much which would have been of value has been omitted. The author has added little to the descriptions of operations in works readily available.

**Sciaticques et Lombalgies par Hernie posterieure des Disques intervertebraux** By D. PETIT-DUTAILLIS, Professeur de Pathologie chirurgicale a la Faculte de Medecine, Chirurgien de l'Hopital Bichat, and S. DE SÈZE, Medecin des Hopitaux de Paris 9½ × 6½ in Pp 180, with 133 illustrations 1945 Paris Masson et Cie Fr 235

**Choc traumatique** Étude clinique, physio-pathologique et therapeutique By J. CREYSEL, Professeur Agrégé a la Faculte de Lyon, and P. SUIRE, Ex-Chef de Clinique Chirurgicale a la Faculte de Paris With a Preface by Professor R. LERICHE 10 × 6½ in Pp 310 1944 Paris Masson et Cie Fr 160

**Hypoglycemies spontanees Le Traitement chirurgical de l'Hyperinsulinisme** By P. MAILLET-GUY, Professeur Agrégé a la Faculte de Medecine de Lyon, and P. MAILLET, Prosecteur a la Faculte de Medecine de Lyon With a Preface by Professor H. MONDOR 7½ × 5½ in Pp 102, with 17 illustrations 1944 Paris Masson et Cie Fr 55

THREE recent publications from the House of Masson et Cie, Paris, and it is interesting to note that this well-known French publishing firm is once again in active production. The first title is a useful work well documented and

illustrated. It begins with a very clear study of the anatomy and pathology of the condition. Later chapters include diagnosis, clinical conditions, and treatment.

In *Choc Traumatique* two surgeons have put out their observations, experiences, reflections, and researches on the subject. In a Preface Professor Leriche commends these two workers and their conclusions. Like most similar works, this book is difficult to understand and the problem remains unsolved.

**Synopsis of the Diagnosis of the Surgical Diseases of the Abdomen** By JOHN A. HARDY, B.Sc., M.D., F.A.C.S., El Paso, Texas. Second edition. 7½ x 10 in. Pp. 528, with 100 illustrations. 1945. London: Henry Kimpton. 25s net.

The second edition of this pocket synopsis of surgical diseases of the abdomen has been carefully revised and brought up to date. It is pleasing to see that one's surgical friends in America are keen in inculcating a clinical atmosphere in the diagnosis of abdominal conditions and not relying entirely on special laboratory reports or X-ray films.

This book advocates painstaking examination of the patient and many useful pictures and diagrams illustrate the best methods of clinical examination. Students and post-graduates will find this a useful pocket book, which is full of sound, practical advice.

## BOOK NOTICES

[The Editorial Committee acknowledge with thanks the receipt of the following volumes. A selection will be made from these for review, precedence being given to new books and to those having the greatest interest to our readers.]

**A Complete Outline of Fractures, including Fractures of the Skull** By J. GRANT BONNIN, M.B., B.S. (Melbourne), F.R.C.S. (Eng.). Second edition. 8½ x 5½ in. Pp. 658 + vii, with 712 illustrations. 1946. London: William Heinemann (Medical Books) Ltd. 30s net.

**Injuries of the Knee Joint** By I. S. SMILLIE, O.B.E., M.B., F.R.C.S. (Edin.), F.R.F.P.S., Surgeon-in-Charge, Orthopaedic Hospital, Larbert, Surlingshire (Scottish E.M.S.). 9½ x 6½ in. Pp. 320 + vi, with 350 illustrations. 1946. Edinburgh: E. & S. Livingstone Ltd. 35s net.

**Synopsis of Genitourinary Diseases** By AUSTIN I. DODSON, M.D., F.A.C.S., Richmond, Va. Fourth edition. 7½ x 4½ in. Pp. 313, with 112 illustrations. 1945. London: Henry Kimpton. 18s net.

**Regional Analgesia** By H. W. L. MOLESWORTH, F.R.C.S. (Eng.), Senior Surgeon, Royal Victoria Hospital, Folkestone. Second edition. 8½ x 5 in. Pp. 92 + viii, with 42 illustrations. 1946. London: H. K. Lewis & Co. Ltd. 8s 6d net.

**The Surgical Clinics of North America** Chicago Number, February, 1946. Symposium on Surgical Technique. 9 x 6 in. Pp. 269 + vi, with 172 illustrations. London and Philadelphia: W. B. Saunders Co. Annual subscription (six numbers), paper 55s, cloth 75s.

**The Surgical Technic of Abdominal Operations** By JULIUS L. SPIVACK, M.D., LL.D., Associate Professor of Surgery, University of Illinois College of Medicine. Fourth edition. 9½ x 6½ in. Pp. 709 + xvi, with 362 illustrations. 1946. Springfield, Ill.: Charles C. Thomas. \$10.00.

**The Surgical Clinics of North America** New York Number, April, 1946. Symposium on Surgical Diagnosis. 9 x 6 in. Pp. 253 + viii, with 72 illustrations. London and Philadelphia: W. B. Saunders Co. Annual subscription (six numbers), paper 55s, cloth 75s.

**Occupational Therapy for the Limbless** By PHYLLIS LITTLETON, C.S.P., M.A.O.T., Late Occupational Therapist, Ministry of Pensions Hospital, Leeds. Drawings by JOAN HARRY. 7½ x 4½ in. Pp. 40 + viii, with 12 illustrations. 1946. London: H. K. Lewis & Co. Ltd. 3s net.

**Diagnostico y Tratamiento de las Varices Esenciales** By J. VALLS-SERRA, Barcelona. 8½ x 5½ in. Pp. 189, with 32 illustrations, mostly plates. 1945. Barcelona: Editorial "Rubi". Pesetas 35.

**The Causation of Appendicitis** By A. RENDLE SHORT, M.D., B.S., B.Sc., F.R.C.S., Professor of Surgery, University of Bristol, Surgeon, Bristol Royal Infirmary. 7½ x 4½ in. Pp. 79 + viii, with 4 charts. 1946. Bristol: John Wright & Sons Ltd. 10s net.

**The Technical Minute of Extended Myomectomy and Ovarian Cystectomy** By VICTOR BONNEY, M.S., M.D., B.Sc. (Lond.), F.R.C.S. (Eng.), Hon. F.R.A.C.S., M.R.C.P. (Lond.). 9½ x 6½ in. Pp. 282 + vi, with 242 original drawings by the Author. 1946. London: Cassell & Co. Ltd. 30s net.

**The Care of the Neurosurgical Patient Before, During, and After Operation** By ERNEST SACHS, A.B., M.D., Professor of Clinical Neurological Surgery, Washington University School of Medicine, Saint Louis. 9½ x 6½ in. Pp. 268, with 177 illustrations. 1945. London: Henry Kimpton. 30s net.

**The Results of Radium and X-ray Therapy in Malignant Disease** Being the Second Statistical Report from the Holt Radium Institute, Manchester. Years 1934-1938, inclusive, assessed at 5 years, and 1932 and 1933 assessed at 10 years. Compiled by RALSTON PATERSON, MARGARET TOD, and MARION RUSSELL. 1946. Edinburgh: E. & S. Livingstone Ltd. 7s 6d net.

**La Méthode du Lever précoce en Chirurgie abdominale** Prophylaxie des Phlébites et Embolies post-opératoires. By ANDRÉ CHALIRE, Professeur agrégé à la Faculté de Médecine de Lyon. 7½ x 5½ in. Pp. 112. 1945. Paris: Masson et Cie. Fr. 70.

**Demonstrations of Physical Signs in Clinical Surgery** By HAMILTON BAILEY, F.R.C.S. (Eng.), F.I.C.S., Surgeon, Royal Northern Hospital. Tenth edition, revised. 8½ x 5½ in. Pp. 375 + viii, with 573 illustrations, a number of which are in colour. 1946. Bristol: John Wright & Sons Ltd. 30s net.

**Essentials of Urinary and Genital Diseases** By SAM I. HADDAD, M.D., F.A.C.S., Professor of Surgery, School of Medicine, American University of Beirut, Lebanon. 9½ x 6½ in. Pp. 207 + vi, with 55 illustrations. 1946. Beirut: American Press. 50s.

**The Anatomy of the Bronchial Tree** With Special Reference to the Surgery of Lung Abscess. By R. C. BROCK, M.S. (Lond.), F.R.C.S. (Eng.), Surgeon to Guy's Hospital, Surgeon to the Brompton Hospital, Surgeon to an E.M.S. Thoracic Surgical Centre. 9½ x 6 in. Pp. 96 + vi, with 142 illustrations, many as plates. 1946. London: Geoffrey Cumberlege, Oxford University Press. 42s net.



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## ENDOMETRIOSIS: A SURGICAL PROBLEM\*

BY PROFESSOR DOUGLAS MACLEOD

THE term 'endometriosis' implies the invasion by the endometrium of tissues to which it is foreign. Of the sites where such invasion takes place, the uterus, ovaries, and the peritoneum of the pouch of Douglas are by far the most conspicuous and the literature on this part of the subject is already very large. From time to time, however, cases are recorded where the locus is situated in tissues either right outside the genital tract, as the bowel, the umbilicus, and the bladder and ureter, or in positions on the very fringe of it, such as the round ligament in the groin or the perineum.

It is my purpose this afternoon to deal mainly with extragenital endometriosis, first, because not much has been written about it, secondly, because it is of interest to all surgeons whose province is the abdomen, and thirdly, because it throws a light on the much debated question of the genesis and method of spread of endometriosis in general.

In the normal woman the characteristic mucous membrane of the uterus is strictly confined to the interior of the corpus, but in the condition known as endometriosis areas of tissue indistinguishable from uterine mucosa are found in other situations. Here they may give rise to the formation of tumours which we call endometriomata, capable of a diversity of puzzling symptoms.

The tissue of an endometrioma is remarkable in that it is subject to the same cyclical changes as the uterine mucosa in its normal situation—that is to say, proliferative and secretory phases at ordinary times, and, in the event of a pregnancy, a decidual reaction comparable with that of the gravid uterus. Like endometrium, therefore, the endometrioma menstruates, but, because it lacks the normal outlet of the uterus, it is forced to retain the products of its menstruation in the form of small intertissue aggregations or, when the ovarian follicle is affected, the 'chocolate' cyst, so characteristic of this condition. These features are evidently dependent on the presence of active ovarian tissue, since endometriosis does not occur before the child-bearing period of life and disappears spontaneously after the menopause, whether natural or artificially induced. It also tends to disappear after a pregnancy, a fact I have been able to verify by laparotomy on such cases. Pregnancy is, however, uncommon in endometriosis because of the high sterility rate with which it is associated.

In its simplest form, endometriosis arises by direct invasion (*Fig 144*). This is exemplified by endometriosis (adenomyoma) of the wall of the uterus, where the spread is certainly by way of the intertissue spaces.

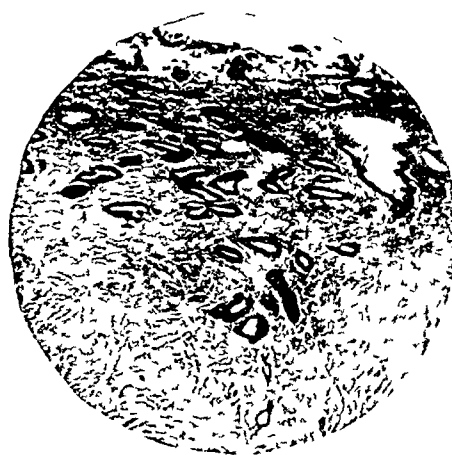


FIG 144—Endometriosis (adenomyosis) of the uterus. The endometrium is seen directly invading the uterine muscle.

Direct invasion, however, does not explain the appearance of endometrial tissue in situations remote from the uterus and Sampson (1921) produced the Implantation Theory, which supposes that endometrial cells pass through the Fallopian tubes during menstruation and become implanted on the ovary and other structures in the pelvis, particularly the peritoneum in the pouch of Douglas. Local invasion of these structures follows, and cysts and tumours are produced containing areas of endometrium and larger or smaller collections of retained menstrual blood.

Iwanoff (1889) and others advanced the Serosal Theory, which holds that under certain conditions the peritoneum, because it is developed from the same structure as the uterine mucosa—namely, the splanchnopleure—has the power to undergo metaplasia and reproduce tissue resembling endometrium. During pregnancy it is common to find small moss-like tufts on the surface of the ovary, in the pouch of Douglas, and even on the peritoneal surface of the bowel, which, when scraped off and sectioned, show pure decidua.

\* Being a Hunterian Lecture delivered at the Royal College of Surgeons of England, May 9, 1946  
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These are probably due to metaplasia, and I think it significant that they are found in sites where it is common for endometriosis to occur. If this theory could be extended to include metaplasia of the granulosa cells of the ovary, also derived from the same embryonic source, many of the puzzling features of endometriosis would be explained. I have, in a previous paper (1934), attempted to demonstrate that these cells appear to be capable of developing an epithelium in ovaries containing endometrial cysts, and it is possible that the 'chocolate' cyst is formed in this way. It must, however, be admitted that proof of metaplasia is lacking, and that once one admits metaplasia, anything can be explained.

Lastly, there is the view that endometriosis arises by lymphatic spread from the uterus, in much the same way as a malignant neoplasm metastasizes by means of the lymphatic system. Strong support for this view has been afforded by the discovery of islands of endometrial tissue in the lymph-glands and even in the lymphatic ducts themselves.

Before discussing extragenital endometriomata it is necessary to give a brief account of the more common manifestations of the disease. In the uterus it gives rise to a tumour very closely resembling a fibroid both in superficial appearance and symptoms—that is, it forms a protuberance and is accompanied by more or less excessive menstrual bleeding. There is, however, a difference, fibroids generally are painless tumours, but uterine endometriomata give rise to severe pain at the periods. This is not to be wondered at since at every menstrual epoch numerous isolated collections of blood are being formed in the dense tissue of the tumour. This severe pain at the time of the periods is characteristic of endometriosis in most of the other situations where it occurs.

Endometriosis when it affects the ovary usually produces what is called the 'chocolate' or 'tarry' cyst (Fig 145). Careful microscopical examination

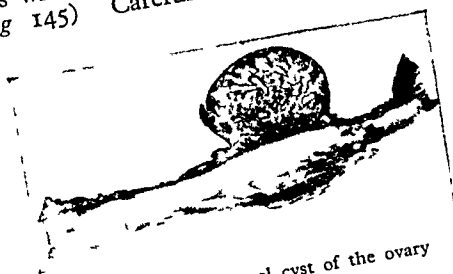


FIG 145—Endometrial cyst of the ovary

of the wall of these cysts discloses in them tissue indistinguishable from endometrium. There can be no doubt at all that such cysts are in fact the ovarian follicles distended by retained menstrual blood. They are frequently multiple in the ovary and may on occasion attain a large size. Their characteristic symptom is the appearance of increasing pain at each monthly period in a patient who has had previously no pain at all. It is a feature of these cysts that they tend to perforate. If this is gradual, the point of imminent perforation becomes adherent to adjacent structures, usually the posterior layer of the broad ligament, and these in turn are invaded by

endometrial tissue. If, on the other hand, the perforation is sudden, the contents of the cyst leak into the peritoneal cavity, giving rise to an acute abdominal emergency. A knowledge of these cysts is therefore of importance to the general surgeon, for the sudden rupture of a chocolate cyst causes severe peritoneal irritation and symptoms closely resembling those of acute appendicitis. Gradual perforation is unlikely to cause so dramatic a picture, but even here a chronic



FIG 146—Peritoneal endometriosis. The rectum is drawn up and adherent to the cervix obliterating the pouch of Douglas—a characteristic feature

appendix may be suspected, and the organ removed without alleviation of the symptoms. In the treatment of ovarian endometriosis it is important to remember that in younger women the main principle must always be to preserve ovarian tissue, and nearly always the cyst, irrespective of its size, can be enucleated from out the ovary. There is another form of endometriosis affecting the ovary which exhibits small superficial areas resembling blood blisters on the surface (Fig 146). It may or may not be associated with similar deposits on the pelvic peritoneum and is essentially part of a peritoneal endometriosis. The peritoneum will show either discrete nodules, some obviously blood-stained, or a diffuse thickening which becomes very adherent and rigid. The front and back wall of Douglas's pouch and the lower part of the posterior face of the broad ligament are the parts most commonly affected, but one case at least is on record where a small endometrioma was found on the under surface of the diaphragm. The rectum becomes characteristically drawn up and, adhering to the cervix, obliterates the pouch of Douglas. Curiously enough, in this situation the characteristic pain is often absent. From the pouch of Douglas extension may occur into the vaginal vault or into the rectovaginal septum—in the latter case even invading the rectum.

I pass on now to the rarer situations in which endometriomata are found.

**Round Ligament**—Seeing that the round ligament is in direct continuity with the uterus it might be thought that endometriosis in it

situation would be common, but such cases are rare, and I have only seen one myself, but Mr Zachary Cope has kindly allowed me to quote a recent case of his. The patient was admitted as a case of strangulated hernia. She complained of a painful swelling in the right groin which varied in size and which she had had for five years. Two years prior to its first appearance she had a hysterectomy for fibroids. Examination showed a firm, tender mass about 1½ in in diameter in the region of the right external inguinal ring. At operation it was found to have no capsule, but there were a number of small blood spaces on the cut surface. Section confirmed that it was an endometrioma. The features of the one case of which I have personal experience were practically identical with those of Mr Cope's patient, and I am also acquainted with another where the swelling was situated well below the level of the external abdominal ring. It was excised and found to be an endometrioma and—this is the most interesting part of the case—a recurrence took place 18 months later lower down still in the substance of the labia majora. This also was excised and proved to be endometriomatous.

**The Perineum**—Cases are recorded of endometriosis affecting the lower part of the genital tract—that is, the cervix, the vagina below the



FIG 147—Endometrioma of the perineum (Mr J White's case)

fornix, and the perineum—but they are rare, and when one considers the many opportunities that are afforded for endometrial tissue to implant, after labour or after repair operations preceded by a curettage, it is rather surprising that this is so, in fact, probably not more than a dozen cases of perineal endometriosis have been described in the literature.

I have been furnished with the details of such a case. She had had one child born in 1935, when the perineum was torn and sutured. A year later she noticed itching in the perineum where a small lump could be felt. Later this began to bleed two days before a menstrual period and after trauma. When seen three years later there was a raised purple warty tumour of fleshy consistency and about the size of a walnut situated in the perineum. It was noticed that the rectovaginal septum above

the tumour was normal, and that there was no apparent abnormality of the pelvic organs (Fig 147). Excision and microscopy confirmed that it was an endometrioma.



FIG 148—Endometrioma of the umbilicus

**The Umbilicus**—Rather fewer than 50 cases of umbilical endometriosis have been reported, and most of these have occurred in the fourth decade of life. It appears as a small lump in the umbilicus, which enlarges and becomes tender at the time of the menstrual period. In some instances bleeding occurred externally from the tumour (Fig 148). Pelvic endometriosis is often present as well. Treatment is by simple excision, but the coexistence of pelvic endometriosis will naturally call for separate measures.

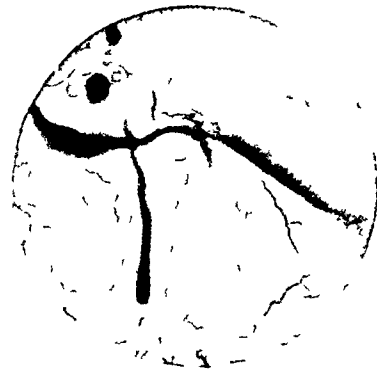


FIG 149—Endometrioma of the bladder. Premenstrual appearance on cystoscopic examination (Mr R B Phillips's case—reproduced from the *Journal of Obstetrics and Gynaecology of the British Empire*, by courtesy of the Editors)

**Bladder**—Endometrioma of the bladder is a very rare, but important, disease. L R Reynolds (1939) collected 34 cases from the literature and added 1 of his own. The bladder may be involved in two ways: either by direct extension from endometriosis of other pelvic organs, such as the uterus or ovary, or it may appear to arise *de novo*.

in the bladder wall itself. The posterior wall of the bladder—in the neighbourhood of the trigone—is usually affected and the ureteric orifices may be involved. The tumour primarily is confined to the muscular wall, but later may invade the epithelial lining. It is not encapsulated and at operation may be mistaken for a carcinoma. In a case reported by Phillips (1934), cystoscopy revealed an ulcerating polypoid growth, leading to a diagnosis of carcinoma, and it was only after a transurethral biopsy had been done that its true nature was recognized. The appearance on cystoscopic examination depends on whether the mucosa is encroached upon. If not, the tumour appears as a rather sharply defined area of congestion, but when the epithelium is invaded, there will be seen grape-like cysts and what has been described by Phillips as "blue folds of oedema" (Fig 149).

The symptoms are usually characteristic. There are cyclical attacks of frequency of micturition, dysuria, and suprapubic pain. If the epithelium is involved, hæmaturia will occur at the time of the menstrual period. Examination of the anterior fornix will show a tender mass in the uterovesical fold and cystoscopy supported by biopsy will clinch the diagnosis.

Treatment depends on (1) the age of the patient and (2) whether the ureteric orifices are involved. As with endometriosis elsewhere in patients in the neighbourhood of 40 years of age, castration by irradiation will be followed by regression of the tumour and disappearance of symptoms in most cases.

In young patients radical resection may be preferable. If the ureteric orifice is involved partial cystectomy and reimplantation of the ureter may be necessary.

Occasionally the condition recurs after local excision and even after castration, and in such cases partial cystectomy is the only course.

**Ureter**—Only 2 cases of primary ureteric endometrioma have been reported, but the ureter may be involved secondarily in endometriosis of the cervix, the pouch of Douglas, the rectovaginal septum, and the ovary if the latter is adherent to the side wall of the pelvis. This occurs far more commonly than is supposed and is a most important factor in some cases of otherwise unexplained recurrent pyelitis, of which I have seen several. Treatment follows along the same principles as before—in young patients excision of the affected part of the ureter with reimplantation into the bladder being required when the duct is deeply affected.

**Laparotomy Scar**—Endometrioma occurring in a laparotomy scar is not rare, and affords the strongest evidence that direct implantation of endometrium can occur (Fig 150). Many of these cases follow operations in which the cavity of the uterus has been opened, such as Cæsarean section, or during myomectomy, or after abdominal curettage. They may also follow salpingectomy and the operation of ventrofixation. Sampson in a recent paper (1945) studied 17 cases, and in 16 the condition had followed a salpingectomy. In his experience the shortest interval between the operation and the appearance of the tumour was two years, the longest seventeen years. Mr Victor Bonney tells me he

has had 6 cases of his own, 5 of which followed abdominal curettage. In none of his cases was the parietal peritoneum involved, nor was there any evidence of endometriosis in the pelvis. The tumours in these cases were undoubtedly the result

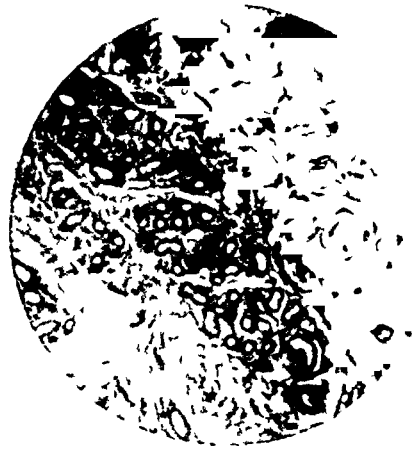


FIG 150—Endometrioma in a laparotomy scar

of direct implantation of endometrium in the abdominal wall, and it is worthy of note that since I used rubber sheeting to protect the exposed tissue of the abdominal wall, he has had no further cases. If laparotomy and inspection of the pelvis indicate that the condition is an isolated one, local excision is enough, but in cases where there is evidence of direct continuity with the uterus or appendage hysterectomy will probably be required.

**The Bowel**—Endometriosis affecting the intestinal tract is the sphere likely to be of most interest and concern to the abdominal surgeon. The small and large intestines may both be the site of endometriosis. In some cases the bowel is found attached to an area of endometriosis in the genital organs, direct invasion occurring in this way. Especially is this likely in the case of the sigmoid colon, while the rectum is prone to be invaded directly from endometriosis in the rectovaginal septum. The appendix, too, may be similarly involved, and Sampson has shown that this is most likely when that organ dips into the pelvic cavity.

It is, however, most important to remember that the bowel may be the site of endometriosis without the pelvic organs being affected, and modifications in the clinical picture are to be expected accordingly.

**The Small Intestine**—The symptoms of intestinal endometriosis are subject to minor variations according to the segment of bowel concerned. In the case of the small bowel the patient will give a history of increasing pain with attacks of vomiting, distension, and constipation which coincide with the monthly periods. Here are two illustrative cases—

The first was a patient aged 44, who had an attack of severe pain in August, 1940, which was diagnosed as an appendicitis. She was seen six months later complaining of severe abdominal pain, and she had

all the symptoms of intestinal obstruction. At operation the small bowel was found to be grossly distended and the colon collapsed. There were two tight strictures, 4 in and 6 in proximal to the ileocaecal valve, closely resembling a carcinoma. Resection of the affected bowel was performed and the patient made an excellent recovery. Microscopy showed that the strictures were due to endometriomatous deposits.

The second was a patient, aged 37, who had had attacks of pain in the right lower abdomen for some time, recently becoming more frequent and finally very severe. An acute appendicitis was diagnosed. At operation, however, the appendix was found to be normal,

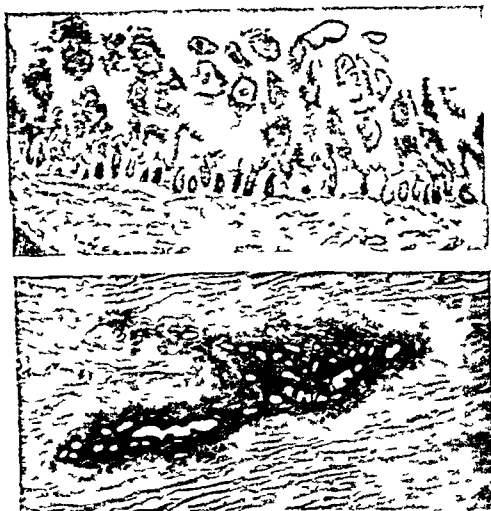


FIG 151—Endometrioma of the small intestine  
(Dr E C Atkinson's case)

but 18 in from the ileocaecal valve the bowel was much puckered over a tumour in its wall about the size of a small walnut and very hard. As the condition was thought to be a carcinoma, resection was performed and the patient made an uneventful recovery. The pathologist reported an adenomyoma of uterine origin (Fig 151).

I would like to emphasize some points common to these two cases. In both, the symptoms were most noticeable at the time of menstruation and were becoming more and more severe. Both at first were considered to be cases of appendicitis, though in the former case signs of intestinal obstruction eventually supervened. At operation both were considered to be carcinoma and were treated with resection. On opening the gut, however, after it had been resected, it was noticed that there was no involvement of the mucosa—a significant observation.

**Sigmoid Colon**—Several cases of endometrioma of the sigmoid colon have been reported. Complete intestinal obstruction in this situation is very rare. Occasionally the patient may pass blood per rectum during a menstrual period, but this is uncommon. The mucosa is rarely invaded and sigmoidoscopy reveals little, except that its performance causes considerable pain and may be difficult owing to surrounding adhesions. Any degree of stricture may be found. I will describe a few cases to illustrate this condition—

The first, a patient aged 40, complained of abdominal pain for a week before each period and constipation was very marked at this time. At operation endometriosis was seen involving the posterior uterine wall, both ovaries, and the pouch of Douglas. There was also a



FIG 152—Endometrioma of the sigmoid colon  
(Mr J B Blaikley's case)

stricture in the middle of the pelvic colon which the surgeon correctly diagnosed as an endometrioma (Fig 152). He performed hysterectomy, removed both ovaries, and resected the involved pelvic loop—performing a Paul's operation. The bowel in this case was completely encircled and it was not possible to get the tip of the little finger through the constricting ring. The mucous membrane was not involved and moved freely over the constriction.

The second, a young woman aged 30, complained of severe premenstrual pain of recent origin in the left ovarian region. Clinical findings made me suspect a left ovarian endometrial cyst. At laparotomy I was surprised to find no evidence of genital endometriosis, but so typical was her history that I explored the bowel, and at the lower end of the sigmoid I found a tumour the size of an olive showing typical blood-spots. I was able to perform a local excision, avoiding a resection which would have been difficult at this level.

The third occurred in a woman, aged 50, complaining of pain in the left iliac fossa which was exacerbated at the menstrual period. She had an endometrioma of the left ovary which had invaded the sigmoid colon. Both ovaries were removed and she is now free from symptoms.

The fourth was a woman, aged 51, with multiple fibroids, but as she had complained of severe left-sided pain, constipation, and distension, her doctor suspected an intestinal growth. He asked me to explore the bowel when I performed the hysterectomy. This I did, and in the pelvic colon I found a tumour the size of a walnut, showing the typical blood-cysts. As she was 51, I did no more than remove both ovaries. Shrinkage must have occurred rapidly, for within three weeks she told me she was now free from pain.

**Rectum**—As endometrium of the pouch of Douglas is common, some involvement of the rectum may be said to be a fairly frequent occurrence. The degree of involvement varies from a mild

condition to an extensive involvement of the bowel, especially in cases of advanced endometriosis of the rectovaginal septum, in fact, cases have been diagnosed as carcinoma and treated by abdomino-perineal excision. The symptoms of pain on defaecation, with bleeding, and a mass felt per rectum, may well lead the surgeon to make a diagnosis of rectal cancer, but if a proctoscope is passed the mucosa appears to be unaffected. The condition may also occur higher up in the bowel and the tumour may appear as a small lump in the rectal wall or may even project into its lumen as a polypus. The following two cases illustrate this condition —

The first was a patient who complained of rectal bleeding. On examination a sessile tumour on the anterior wall was found just in reach of the finger. Under anaesthesia the tumour was drawn down and it was seen to be covered with healthy mucous membrane. This was incised and the tumour dissected out and removed for biopsy. At the same time, it was found that the base of the tumour involved the pelvic peritoneum and removal had caused an opening into the peritoneal cavity. A second tumour higher up was not accessible for removal per rectum. The abdomen was therefore opened and extensive pelvic endometriosis was revealed. Further treatment was limited to the induction of the menopause by X rays. She reported three years later, again complaining of rectal bleeding. I was asked to see her and found she had been taking stilboestrol for some months, which had, presumably, re-established the condition of endometriosis and consequently bleeding was occurring from the remaining polypus. At all events, when she was taken off stilboestrol the bleeding ceased.

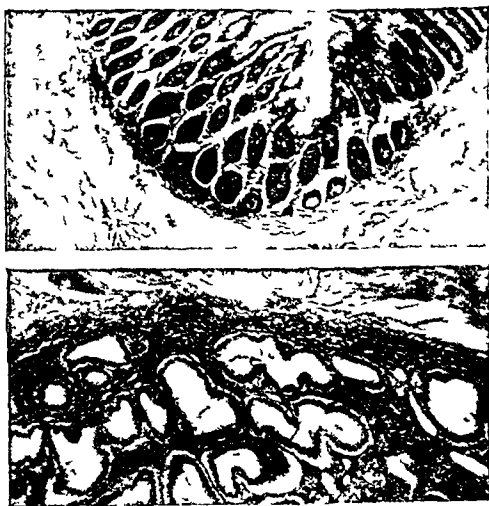


FIG 153 —Endometrioma of the rectum

The other case was of a different nature. The patient, aged 34, had been transferred from another hospital where laparotomy had revealed a tumour of the rectocolic junction. She complained of rectal bleeding at the menstrual periods and dysmenorrhœa of some months' duration. Examination showed a mass in the pelvis and extensive thickening in the anterior rectal wall, and a diagnosis of rectal carcinoma was made. An abdominoperineal excision was performed and the patient made an excellent recovery (Fig 153). Histological

examination of the growth showed an endometrioma. She remained symptom-free for about eighteen months, when she returned complaining of abdominal pain. The uterus was found to be retroverted and fixed, and a recurrence of endometriosis was thought to be sufficiently probable to warrant a small dose of intra-uterine radium. Ten months later she became pregnant and was delivered by Cæsarean section.

I saw her at the end of 1945. She is now 51 and has seen no periods for three years. Pelvic examination revealed no evidence of endometriosis and she is well and free from symptoms.

From a study of the previous cases of intestinal endometriosis it will be observed that it may be extremely difficult, if not impossible, to differentiate endometriosis from carcinoma when the abdomen is opened. The main points that may be helpful in distinguishing the two are first, the association of pelvic endometriosis, secondly, the presence of blood-cysts in the tumour, if visible, and thirdly, for the size of the growth, secondary involvement of the glands in endometriosis is either absent or, if present, minimal. Nevertheless, in many cases differentiation from carcinoma at the time of operation is not possible with any degree of certainty, and in all cases in which there is doubt resection of the affected loop is the proper course. This applies, too, to all young patients even when the diagnosis is *not* in doubt if the condition is too extensive for local excision.

It is only possible to modify treatment in undoubted cases of endometriosis in patients over 40 where induction of an artificial menopause by oophorectomy or radiation will avoid the need for more extensive and dangerous procedures. It may even be called for in young subjects where the pelvirectal junction or rectovaginal septum is so extensively involved that abdomino-perineal resection is the only operative procedure capable of removing the growth.

### THE GENESIS AND METHOD OF SPREAD OF ENDOMETRIOSIS

I have postponed this discussion to the last because the occurrence of endometrioma outside the genital area has an important bearing on the subject.

The phenomenon of endometriosis is unique in this respect, that a whole normal adult tissue—not a single type of cell—transplants itself and grows in tissues foreign to it. Throughout active sexual life the endometrium is renewed every month, with the result that it never grows old, in fact, it is a 'Peter Pan' amongst tissues, perpetually retaining that vigorous growth propensity which makes it peculiarly suitable for tissue culture. In proof of this, twelve years ago, in this College, at Mr Victor Bonney's suggestion, human endometrium was grown successfully *in vitro*.

With this knowledge, the occurrence of endometriomata in laparotomy scars by direct implantation becomes an event which one would expect occasionally to happen, and, further, one might anticipate that at times the endometrium would invade the uterine muscle that underlies it. What, in the first instance, tips the balance between the growth power of the endometrium and the resistance

of the muscle, is unknown to us, but it is certain that in uterine endometriosis invasion occurs along the intertissue spaces—a lymphatic permeation, in fact—the invaded tissues reacting by hypertrophy and fibrosis until a definite, though unencapsulated, tumour mass is formed. In the case of endometriosis of the ovaries and pelvic peritoneum the most popular explanation is the 'spill' theory of Sampson (1921), and as far as surface endometriosis is concerned, this is adequate. A difficulty arises in the case of the endometrial cysts of the ovary (chocolate cysts) which, it is to be remembered, are, of all types of extra-uterine endometriosis, by far the most common. They are sited in the ovarian follicles, often quite deeply embedded in the ovary and enucleable from it. Fragments of endometrium escaping from the tube could only find their way into a follicle after dehiscence, whereas many of the follicles affected have almost certainly never dehisced. The serosal theory is also incapable of explaining their occurrence, unless it is postulated that the follicular cells themselves can undergo such metaplasia. As yet, there is no proof of this.

There remains the Lymphatic Theory. The ovary is in direct lymphatic communication with the uterus and being an 'end-organ' is frequently the site of secondary carcinomatous deposits, especially when the primary growth is in the uterus. The rectum and rectocolic junction, the bladder, and the lower end of the ureter are so close to the uterus that no great length along the intertissue spaces has to be traversed. The appendix, colon, and small intestine are farther afield, but they are in communication through their mesenteries with the retroperitoneal tissue, of which the parametrium forms a part. Cases have been published where endometriomatous deposits have been found in the inguinal, pelvic, and mesenteric glands. They have even been found in the lymphatic ducts themselves—this is direct proof of lymphatic conduction.

The occurrence of umbilical endometriosis cannot be explained by any theory other than that of lymphatic spread, and in this connexion I would remind the reader of the work of Sampson Handley (1910), who showed in his study of the "Surgery of the Lymphatic System" that the umbilicus is richly supplied with lymphatics and that secondary deposits may occur there when intraperitoneal carcinomatous cells are implanted on the anterior parietal peritoneum. The presence of these metastases, he asserts, is proof that cancer cells have obtained access to the peritoneal cavity. It is noteworthy that in cases of umbilical endometriosis, obvious pelvic endometriosis frequently coexists.

It appears, therefore, from a survey of all the facts at our disposal that endometriomata wherever they occur are the result of the endometrium taking upon itself lymphatic permeation. The occurrence of 'tubal spill' cannot be absolutely disproved, but when we have an hypothesis adequately covering all the known facts it seems unnecessary to put forward a second one which only accounts for a few of them. Moreover, allowing that spill occurs, we still have to invoke lymphatic permeation to account for the occurrence of endometriomata in positions remote from the peritoneum.

## EPILOGUE

In the foregoing I have tried to cover the main features of endometriosis as it is likely to concern the general surgeon as much as the gynaecologist.

I have indicated the various syndromes that may result from its extension beyond the genital tract, and I have referred to the theories that explain, or attempt to explain, the manner of its extension.

There remains but one issue still to be discussed, and I will make it the epilogue to my subject, even though it means that I must end on a note of interrogation. It is this: What place in the pathological gallery should be assigned to the picture of endometriosis? Where does it properly belong in our catalogue of diseases, that it may be seen in its true perspective in relation to other pathological processes whose position is more assured?

Clearly it is of the order of a growth, and an abnormal growth at that. Is it malignant, or is it benign?

In the vigour of its growth, in its power of invasion, and in its tendency to metastasize, it undoubtedly resembles a malignant growth. But the normal endometrium has the same vigour even outside its natural habitat, as was shown by successful tissue culture.

Further, the tissue of an endometrioma, whatever it may be, is under the same rigorous functional control as the normal endometrium—namely, that of ovarian activity. And even in its metastases, the extent of its invasion seems to be limited. Where in the sphere of malignancy is there anything comparable with this? On the other hand, we are not justified in describing the endometrioma as a benign growth and there letting the matter rest. There is much more to it than that. For instance, we have only considered the part played by the ovary in controlling the behaviour of endometriomata. Is it possible that some abnormality of ovarian or related endocrine function may be responsible for its occurrence? This view recalls the analogous theories advanced by workers on cancer, seeking to incriminate the endocrine system as the responsible agent in the production of malignant growths.

However this may be, it seems that endometriosis must be accorded a position somewhere between benign and malignant growths, two separate states of which the true relation has so far escaped the most searching scrutiny.

Is it too much to hope that further study and research in this problem will bring with it the key to the essential nature of malignancy itself?

I am greatly indebted to my many friends and colleagues who have so kindly allowed me access to the notes of their cases and supplied me with valuable information.

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## SOME RECENT ADVANCES IN PANCREATIC AND BILIARY TRACT SURGERY

### INCLUDING SOME CASE REPORTS

BY T M J D'OFFAY, LEICESTER

CARCINOMA arising from the duodenal papilla, ampulla of Vater, and the distal inch of the common bile-duct and pancreatic duct (henceforth in this paper called ampulla-papillary carcinoma) must be carefully distinguished from carcinoma of the head of the pancreas proper, because although they have many features in common, they differ fundamentally in their pathology and prognosis, and to a lesser degree in their clinical course. But owing to the difficulty of diagnosing one from the other both before and at operation, and because of the similarity of the surgical procedure employed for both, these two lesions are best considered together—due emphasis being paid to their dissimilar features. The ampulla-papillary group of carcinomas are considered as of one type because of the impossibility of determining the exact site of origin in many cases, even after careful microscopical examination (Ewing, 1928, Hunt and Budd, 1935, Outerbridge, 1913).

Carcinomas in this region have hitherto been looked upon as the most formidable of diseases, and have shared the honours with carcinomas of the oesophagus as the last to yield to the skill and ingenuity of the surgeon, who has been greatly helped in this respect during the last 10 years by advances in biochemistry and in blood and plasma transfusions. The age of the patient, the deep retroperitoneal position of these growths, their close relationship to vital blood-vessels, and the development of

jaundice with subsequent failure of the liver functions are the factors which gave a practically hopeless outlook to these lesions—so much so that in 1905 Lord Moynihan, when discussing the few cases (13 in number) that had been subjected to operation up to that time, wrote "The results serve to show that the mechanical difficulties of the operation are well-nigh insuperable, and that if boldness and good fortune are the operator's gifts, the result to the patient hardly justifies the means". This attitude prevailed and was reiterated by surgeons from time to time until 1935, when Whipple, Parsons, and Mullins (1935) stimulated new interest in this subject by their able advocacy of a new two-stage operation.

### AETIOLOGY AND INCIDENCE

Nothing is known of the aetiology of the disease. Carcinoma of the ampulla-papillary region occurs in 1·13 per cent of all carcinomas, and 0·09 per cent of all autopsies (Lieber, Stewart, and Lund, 1939). It is an uncommon tumour, 222 verified cases having been reported in the literature up to 1939 (Lieber et al., 1939). The age and sex incidence is the same as for carcinoma of the pancreas.

Carcinoma of the pancreas accounts for 3 per cent of all cancer deaths (Clute, 1936). The age incidence is similar to that of carcinoma of the stomach, and the male/female ratio is 2 to 1. Rives,



Romano, and Sandifer (1937) give the following ratio of distribution from a collective review of 415 cases head 66 per cent, body and head 18 per cent, body 6 per cent, and tail 10 per cent (Fig 154)

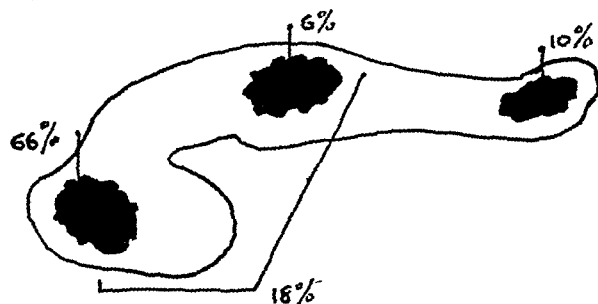


FIG 154—Distribution of carcinomata in the pancreas (After Rives, Romano, and Sandifer, 1937)

The relative incidence of ampulla-papillary carcinoma and carcinoma of the head of pancreas has received scant attention. Accuracy demands confirmation of the diagnosis by biopsy or autopsy. The figures given by Schnedorf and Orr (1941) and by Ransom (1938) alone meet these requirements, but are perhaps too small to be of value. The proportion of carcinoma of head of pancreas to ampulla-papillary carcinoma is approximately 8 to 5.

### **PATHOLOGY**

**Ampulla-papillary Carcinoma**—All pathologists who have studied the subject are agreed that carcinomas arising from the ampulla-papillary region are of two types—a papillomatous growth projecting into the duodenum and measuring 1–3 in in diameter, or a flat ulcerating growth which may be so small as to remain undetected in a hurried examination or simulate a stricture of the lower end of the common bile-duct. These tumours remain localized for a relatively long time, rarely invading the head of the pancreas, and are late in metastasizing to the regional lymph-nodes. Such favourable features are probably due to the early onset of jaundice, and were first pointed out by Outerbridge (1913), who found metastases in 22 per cent of 110 cases reported in the literature up to that time. Dick (1939) has recently confirmed those findings. A review of the reported cases (Table I) reveals that lymph-node metastases occurred in 24.6 per cent of the cases.

Table I—INCIDENCE OF LYMPH-NODE METASTASES IN AMPULLA-PAPILLARY CARCINOMA

Author	No of Cases	Metastasis Present
Perry, and Shaw (1893)	15	3 (20 per cent)
Outerbridge (1913)	110	24 (22 per cent)
Cohen and Colp (1927)	4	0
Whipple et al (1935)	7	2 (28 per cent)
Ransom (1938)	5	0
Bagenstoss (1938)	28	15 (53.6 per cent)
Dick (1939)	13	1 (7.7 per cent)
	182	45 (24.6 per cent)

**Carcinoma of the Head of Pancreas**—The head alone is the seat of growth in 40–66 per cent of cases. The growth arises from the epithelium of the acini or smaller ducts, and is usually hard and scirrhous. The grade of malignancy is unfortunately high in most cases (81 per cent), corresponding

to gastric carcinoma in this respect. Drapiewski (1944), of the Mayo Clinic, found the following grades of malignancy in 82 carcinomas of the pancreas: Grade 1, 1 case (1.2 per cent); Grade 2, 14 cases (17 per cent); Grade 3, 33 cases (40 per cent); Grade 4, 34 cases (41 per cent). "Because of its highly infiltrative growth, the exact limits of the neoplasm are not discernible. Indeed, microscopical section usually shows extension of malignant cells at some distance into pancreatic tissue which appears grossly uninvolved" (Brunschwig, 1942) (see Case 3 reported here). At operation or autopsy invasion of the duodenal wall, mesocolon, and adjacent blood-vessels is a frequent finding. Finally, metastases to lymph-nodes, liver, and lungs occur relatively early. Drapiewski (1944) found metastases in lymph-nodes in 73.2 per cent of 82 cases examined. All reports agree that early and extensive metastases are the rule, and that the disease is rapidly fatal, the illness averaging 4½ months. Of 12 cases reviewed at autopsy, Ransom (1938) found only 2 cases operable, one in the head, the other in the body. Of 46 cases of carcinoma of the head of the pancreas and ampulla-papillary region seen during a 2-year period (1942–4), Cattell (1945) reports 3 radical excisions for carcinoma of the head of the pancreas, whereas there were 13 such excisions for ampulla-papillary carcinoma.

### **DIAGNOSIS**

**Clinical Features**—Carcinoma of the ampulla-papillary region and to a less extent of the head of the pancreas possesses only one good feature—the development of jaundice at a relatively early stage of the disease. Classically the jaundice is painless and progressive, but recent studies have definitely proved that in a high proportion of cases the jaundice is neither painless nor progressive.

Icterus occurs in practically all cases of carcinoma of ampulla-papillary region. It was present in 105 of 110 cases reported by Outerbridge (1913), and in all 52 cases reviewed by Pallin (1920). In carcinoma of the head of the pancreas, jaundice was observed in 86 per cent (Rives et al, 1937) and 81 per cent of cases (Berk, 1941), and severe abdominal pain in 46 per cent of cases (Drapiewski, 1944). When carcinoma of all parts of the pancreas are considered the incidence of jaundice is naturally lower (71 per cent) and pain higher (76 per cent) (Drapiewski, 1944). Indeed, pain is a major complaint in such cases. In Ransom's series (1938) of 109 cases of carcinoma of the pancreas and bile-ducts, abdominal pain was the major complaint in 45 per cent of cases and the most common initial complaint. In half the cases the pain was felt in the epigastric region and had a continuous boring character, going through to the back. In the others the pain closely resembled mild attacks of biliary colic. Pain associated with carcinoma of ampulla-papillary region is almost invariably of the latter type.

Loss of weight, anorexia, and asthenia are early, rapidly progressive features in carcinoma of the head of the pancreas, usually preceding the jaundice, whereas in ampulla-papillary carcinoma they are less marked and manifest themselves only after the onset of jaundice (Cattell, 1945).



Reflex vomiting occurs in one-third of the cases, while progressive vomiting due to duodenal obstruction by growth occurs occasionally as a late or the only presenting feature of the disease. Severe constipation is present in over a third of cases (36 per cent) and steatorrhœa in 12 per cent (Ransom, 1938).

Fever and rigors occur occasionally, and may be conspicuous features (*Case 4*, herein described).

Examination of the abdomen usually reveals the edge of an enlarged liver, and may reveal the presence of a pancreatic tumour (23 of 35, i.e., 65 per cent, cases of carcinoma of pancreas—Schnedorf and Orr, 1941) (tumours of the ampulla-papillary region are usually too small to be palpable), secondaries in the liver and peritoneum, free fluid in the peritoneal cavity, and finally a dilated gall-bladder. One should be chary of concluding inoperability when there is free fluid in the peritoneal cavity. The writer has observed two cases of carcinoma (one pancreatic, one gastric) during 1945, in which free fluid in the peritoneal cavity was caused by starvation hypoproteinaemia. In both cases the free fluid completely disappeared after the administration of a high protein and carbohydrate diet.

Dilatation of the gall-bladder is present in nearly all cases. Its detection clinically or at peritoneoscopy or operation is of such diagnostic importance that we should pause to consider its significance in some detail. Courvoisier's law, which is concerned with the problem, states literally "With obstruction of the common duct by stone, dilatation of the gall-bladder is rare, the organ being usually shrunken. With other types of obstruction, on the other hand, dilatation is the rule, shrinking occurring in only one-twelfth of the cases." This law was enunciated by L. G. Courvoisier in a small monograph dealing with the pathology and surgery of the biliary tract published in 1890. In this he described the condition of the gall-bladder in 187 cases of obstruction of the common bile-duct with jaundice. In 87 cases the obstruction was due to stones, and of these 80 per cent had a shrunken gall-bladder. On the other hand, in 92 per cent of the 100 cases, in which obstruction was due to causes other than stones, the gall-bladder was distended. Courvoisier went on to explain this striking difference by pointing out that infection of the gall-bladder wall, nearly always present with stones, produced so much fibrosis that dilatation was impossible. With other causes the thin-walled bladder was able to dilate, sometimes to large proportions.

This law has since been fully confirmed repeatedly. Cabot (1909) gives the following figures for 86 cases studied: 57 cases of stones in common bile-duct—in 2 only was the gall-bladder dilated, whereas in 29 cases of carcinoma of the head of the pancreas, only 2 did not present a distended bladder. Thus 4 cases out of 86 proved the exception to the rule. Ransom (1938) found a dilated gall-bladder in 83 per cent of 109 cases of obstructive jaundice due to carcinoma.

Clinically it is possible to feel the distended gall-bladder in only half the cases (Eustermann, 1922, 138 cases studied). Thus Courvoisier's law is of much greater practical importance at peritoneoscopy or laparotomy than at the bedside.

**Radiography**—In Lieber, Stewart, and Lund's (1939) series positive evidence of a lesion in the region of the papilla was found in 16 of 60 cases (27 per cent). In carcinoma of the head of the pancreas positive evidence in the form of widening of the duodenal curve or compression or invasion of the duodenal lumen usually signifies a late stage of the disease (Brunschwig, 1942).

**Tests of Liver Function**—These tests are most useful and constitute an important advance in the diagnosis and treatment of jaundiced states. It is well to know that these tests have certain limitations, and to remember that the liver is an organ performing many functions, which are not equally injured by a disease process or toxic agent. There is "dissociation of the functional activities of the liver" (Mann, 1942). The value of the tests is that, on the one hand, they reliably assist in the diagnosis between obstructive and hepatogenous jaundice, and on the other they detect the presence or absence of liver insufficiency. A knowledge of the latter is, of course, of the greatest importance in guiding the pre-operative treatment, the type of operation and post-operative management, and in the prognosis.

The absence of bile in the duodenal contents and faeces, and the absence of urobilinogen from the urine signify complete obstruction of the bile-ducts—the classical features of obstructive jaundice, in the early stages of which the liver functions are normal. On the other hand, there is the typical picture of hepatogenous jaundice with bile in the stools and increased amount of urobilinogen in the urine with failure of the liver functions early in the disease. Now, if these two types of jaundiced states remained as such, or if all cases of jaundice could be seen within one or two weeks of onset, there would be little difficulty in distinguishing one from the other. But the types tend to merge. Obstruction is complicated by hepatitis, and hepatitis by obstruction. In obstructive jaundice due to stone or neoplasm in the bile-passages, liver damage is brought about by continued back pressure or by infection or both. In pure hepatogenous jaundice (toxic, infective, and cirrhotic), intra-hepatic biliary obstruction occurs in 20 per cent of cases (Steigmann and Popper, 1943). Indeed, these authors found evidence of some obstruction in nearly all cases of hepatitis, but complete obstruction of 2–30 days' duration occurred in 20 per cent of 127 cases studied. The liver in these cases shows dilatation of the small bile capillaries within the parenchyma all the way to the portal triads (Popper, 1936, Hanger, 1940). According to Aschoff (1937) "The morphologic picture localizes the obstruction in the region of the periportal fields at the junction between the bile capillaries and bile-ducts. Here the most vulnerable part of the biliary system is localized."

Steigmann and Popper (1943) proceed to show that the simplest way of recognizing the real nature of these cases of hepatitis complicated by intra-hepatic obstruction is to determine the urobilinogen excretion in the urine for a prolonged period. An isolated estimation may give an erroneous impression. "A continuous observation of the urobilinogen excretion throughout the course of the disease would

show first an increase, then a decrease (period of obstruction), and then again a rise before improvement, and finally a drop to normal levels."

Urinary urobilinogen originates from changed bilirubin, which is absorbed from the intestinal tract. Normally the liver oxidizes nearly all the urobilinogen re-absorbed from the intestine, and small amounts only appear in the urine (up to 3 mg in 24 hours). Liver damage interferes with this oxidation, and large amounts of urobilinogen are therefore excreted daily in the urine (5-300 mg), the amount depending on the severity of the liver damage. Complete obstructive jaundice, on the other hand, shows a gradual but persistent decline in traces of urobilinogen found initially in the urine. A small amount of urobilinogen (up to 5 mg) may be present in the faeces, this being derived from bile-stained debris coming from the wall of the intestine (Steigmann and Dyniewicz, 1943).

The plasma prothrombin response to intravenous injection of vitamin K is another test used in the differential diagnosis of jaundice. The normal prothrombin content of plasma is maintained by adequate absorption of vitamin K from the bowel, and its conversion into prothrombin by the liver. And prothrombin deficiency may be due to the failure of either or both these functions. In the absence of intestinal bile, the resulting prothrombin deficiency is rapidly corrected by giving vitamin K (a quick response). Conversely, prothrombin deficiency due to hepatitis cannot be, or is slowly, corrected by administering vitamin K (no response, or a slow response). Olwin (1941), Lord and Andrus (1941), Allen and Julian (1942), and Allen (1944) are all agreed that this test offers an accurate method of differential diagnosis in early cases of jaundice and in the absence of infection complicating obstruction. They emphasize the importance of observing certain technical details in performing the test. This test is also a valuable one for estimating hepatic insufficiency—"the most practical we now have" (Ivy and Roth (1943)).

In some respects all tests of hepatic functions are helpful in the differential diagnosis of jaundice, provided they are done in the early stages of jaundice, that is, before the types tend to merge. They indicate poor function in cases of hepatitis, and give normal results in early cases of pure obstruction. The galactose tolerance test of Bauer (1906), hippuric acid synthesis test of Quick (1932), and cephalin-cholesterol flocculation test of Hanger (1939) have all proved useful in this respect, but their chief merit lies in determining damage and residual function (Ivy and Roth, 1943). The bromsulphthalein (5 mg) clearance test of Rosenthal (1922) is unreliable in the presence of jaundice, but one of the most sensitive indices of liver damage in the absence of jaundice.

**Aspiration Liver Biopsy** has proved of great value in the diagnosis of obscure and difficult cases. The technique has been well described by Sherlock (1945). It has definite limitations and is not without danger—0.67 per cent deaths from bleeding (Sherlock). Failure to aspirate a cylinder of tissue occurred in from 2-10 per cent of Sherlock's cases. The specimen having been obtained, however, there is no difficulty in coming to a diagnosis, except in

old-standing cases of biliary obstruction which give a picture not unlike an ordinary cirrhosis.

**Peritoneoscopy**—This procedure is, in my estimation, of much greater value than aspiration biopsy, since it allows one to view the liver, gall-bladder, and the peritoneal cavity generally, and to take a biopsy of the liver. This is done with less risk (0.2 per cent mortality, Ruddock, 1937) than aspiration liver biopsy, and with as little discomfort to the patient. I have used this method of investigation and diagnosis on several occasions and found it most useful, if only to prove or disprove the presence of secondary growths. Biopsy of the liver is easily and safely carried out under vision, and hæmostasis secured by electro-coagulation.

**Diagnosis at Operation**—There is usually on difficulty in coming to a diagnosis in those carcinomas of the ampulla-papillary region which project into the duodenal lumen. But those which invade the pancreas and those arising from the head of the pancreas proper may give rise to acute diagnostic problems. Chronic pancreatitis localized to the head (usually), and adenoma (rarely), and calcification of the pancreas (6 recorded cases—Gordon Taylor, 1942, Whipple, 1945) may so closely simulate carcinoma as to be indistinguishable from it. Almost every experienced abdominal surgeon has at some time seen a case of chronic pancreatitis mistaken for carcinoma and vice versa (see Case 5). Walters and Dehne (1932) estimated that 15 per cent of cases diagnosed as carcinoma of the pancreas were inflammatory lesions as judged by the end-results of short-circuit operations. Sir John Fraser (1938), in his survey of 1035 cases of jaundice treated between 1927 and 1937, stated that "7 per cent of simple cases are mistaken for malignant disease, and 16 per cent of malignant cases are classified as simple." Cattell (1945) reports a mistaken diagnosis in at least 5 (10 per cent) of 51 cases diagnosed as carcinoma of the pancreatico-duodenal region during a two-year period. Four of these had a preliminary cholecyst-jejunostomy performed, later at a second operation nothing was found in three, and a simple tumour in the fourth. The fifth case was subjected to a successful resection of the duodenum and head of the pancreas, but the lesion proved to be pancreatitis.

Examinations of frozen sections "while you wait" at operation may prove either misleading owing to pancreatitis accompanying the tumour and overlying carcinoma tissue (Brunschwig, 1942) or useless (Cattell, 1945). Moreover, there are cogent objections to incising a pancreatic tumour unless one is prepared to carry out an immediate resection. It would seem that the best procedure to adopt in cases of doubt is to do a preliminary cholecyst-jejunostomy, and if enlarged lymph-nodes are present to remove one or more for microscopical examination. The second operation, if indicated after lymph-node biopsy, will in most cases reveal the true diagnosis, as in Cattell's cases.

## TREATMENT

Prior to 1937, when Brunschwig performed successfully a modified Whipple operation for carcinoma of the head of the pancreas, few attempts had been made at the radical removal of this growth

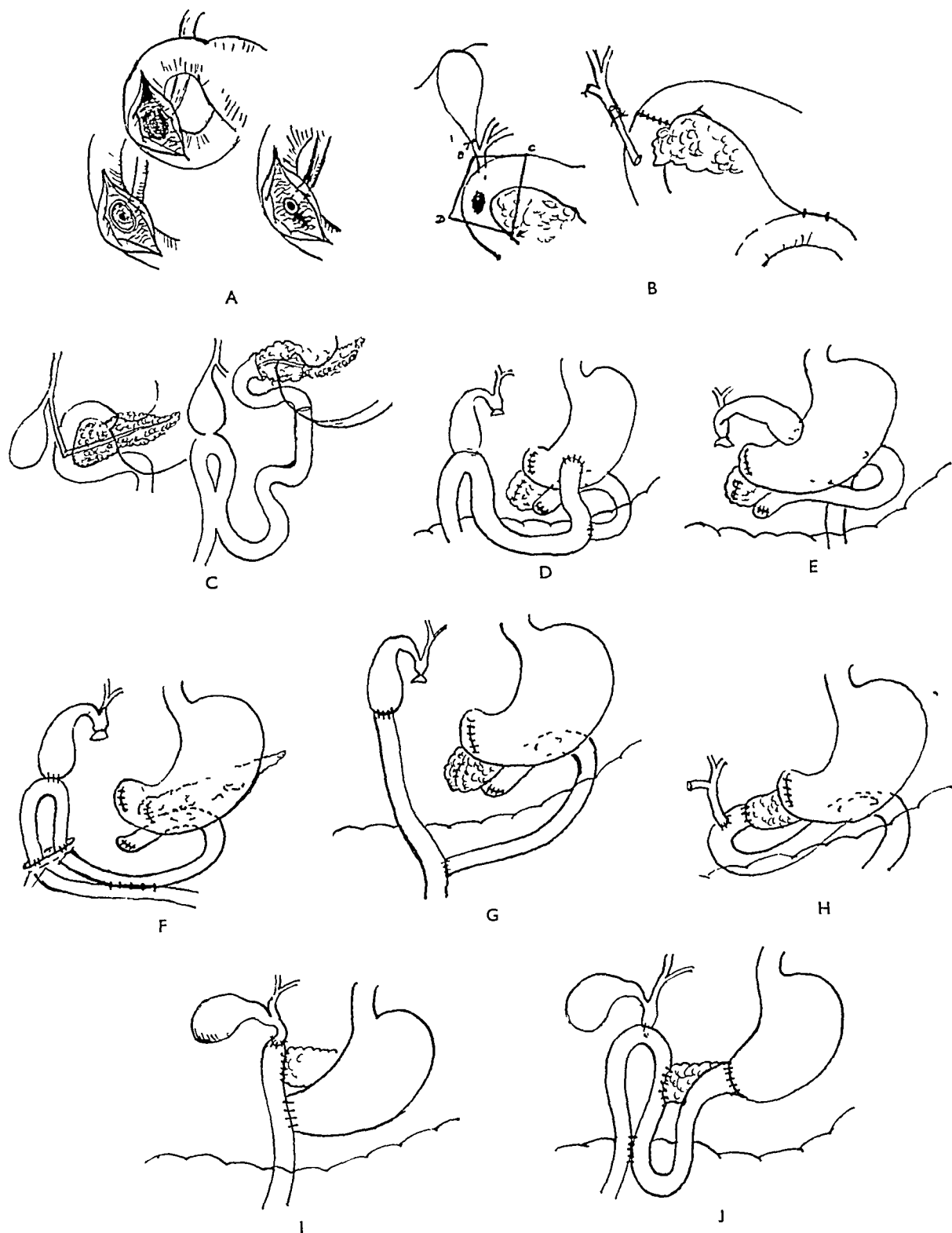


FIG 155—Early operations for ampulla-papillary carcinoma. A, Simple transduodenal excision, B, Hirschel's (1914) operation an example of limited cylindrical excision of the duodenum with wedge excision of head of pancreas and end-to-end anastomosis of duodenum. C, Kausch's operation (1912) (two stage) for radical excision of head of pancreas and duodenum—first operation for carcinoma of head of pancreas. D, Codivilla's radical pancreatico-duodenectomy performed in 1898—radical operations carried out since 1935 for both types of cancer. E, Whipple, Parsons, and Mullins (1935). F, Brunschwig (1937), G, Whipple (1938), H, Hunt (1941), I, Whipple (one-stage) (1943) and J, Cattell (1943).

Codivilla in 1898 resected the duodenum and head of pancreas in one stage and by a technique which is very similar to those now in vogue (Fig 155, D). To him, therefore, should priority be accorded in the development of radical pancreatoduodenal resection. His patient died 24 days after operation, Tuffier (1905) and Michaux (1906) also carried out resection of the duodenum and head of the pancreas, but without success.

Carcinoma of the ampulla-papillary region, on the other hand, by virtue of its intraduodenal position, its small size, and very localized nature, has proved more amenable to surgical extirpation. In 1898 Halsted (1899) performed the first excision of such a cancer. The operation consisted of a wedge resection of duodenum and growth, and the patient died from a local recurrence nine months later. From then on until 1935, when Whipple, Parsons, and Mullins described their two-stage radical operation for this lesion, no less than 78 reports of limited excision of these tumours appeared in the literature. These early operations were of two types: in most cases a simple and crude removal of the tumour was carried out after gaining access by opening the anterior wall of the duodenum (Fig 155, A), in a few cases (5 reports, including Halsted's original case) (Mayo-Robson, 1900, Korte, 1904, Hirschel, 1914, Tenani, 1922), the operation consisted of a cylindrical or wedge resection of the duodenum, and wedge removal of the adjacent portion of the pancreatic head containing the tumour (Fig 155, B). Kausch in 1912 devised and performed a two-stage radical excision of the duodenum and head of the pancreas, which was in many respects similar to the present-day operation (Fig 155, C). His patient died nine months later from acute cholangitis without evidence of metastases.

The operative mortality for these operations was 29 per cent for transduodenal excision, and 45 per cent for cylindrical duodenal excision (Hunt, 1941). It is interesting to compare these figures with the operative mortality-rate following simple laparotomy (36 per cent), cholecyst-gastrostomy and cholecyst-jejunostomy (32 per cent), and simple cholecystostomy (70 per cent) (Cohen and Colp, 1927). Sir John Fraser (1938) in his review gave the following mortality figures for simple internal short-circuit operations: 40 per cent for all cases of obstructive jaundice, 51 per cent in malignant disease of the pancreas, and 19 per cent in chronic pancreatitis. In more than half the cases (58 per cent), the cause of death was cholæmia, shock, peritonitis, and hæmorrhage in equal proportion accounting for the other deaths. He also pointed out the close relationship that exists between the degree of jaundice and the mortality-rate (the deeper the jaundice, the higher the mortality). With regard to the favourable mortality figures quoted above for transduodenal and other excisions as compared with cholecyst-gastrostomy, it must be remembered that unsuccessful cases are seldom reported. If these, then, are taken into consideration, the mortality percentage for excision may well have equalled or even surpassed that following cholecyst-gastrostomy. Thus the position stood until 1935: three unsuccessful attempts at radical removal of the duodenum and head of the pancreas for carcinoma

of head of the pancreas, and two successful two-stage limited radical resections for carcinoma of the ampulla-papillary region by Kausch (1912) and Tenani (1922). The other successful excisions, with the exception of Hirschel's, had been of a very limited character, and performed through an opening in the duodenum.

As a result of certain mistakes and a fatality in 1934, Whipple, Parsons, and Mullins (1935) re-examined this problem with a view to eliminating the defects of the previous operations and devising a safer and more radical procedure. They pointed out the error of performing the operation in one stage, and they recognized that the resection as hitherto carried out had been limited in extent in order to preserve as much duodenum as possible, and to safeguard the entrance of pancreatic juices into the intestine, both of which were generally considered essential for life. Whipple and his colleagues, however, knew that the dog could survive total duodenectomy, a demonstration of the greatest importance which was first made by Dragstedt et al in 1918 and later confirmed by Moorhead and Landes (1919) and Mann and Kawamura (1919). Fortified by this knowledge, and by the fact that patients suffering from carcinoma of papilla of Vater are able to survive for months without pancreatic external secretions (Whipple, 1941), Whipple, Parsons, and Mullins were prepared to sacrifice both the duodenum and pancreatic juices in order to plan and carry out a truly radical resection for carcinoma. This they did successfully for ampulla-papillary carcinoma in 1935. The operation was performed in two stages, the first stage consisting of cholecyst-gastrostomy and gastro-jejunostomy, resection of most of the duodenum and of head of the pancreas with closure of the duodenal ends and pancreatic stump was performed two weeks later (Fig 155, E). The patient made a rapid recovery, and there was no subsequent interference with the digestion of fat and protein, or with carbohydrate metabolism. This operation represents a milestone of progress in the surgery of the pancreas, duodenum, and biliary tract, and with some modifications it has now been carried out on at least 125 occasions since 1935.

Brunschwig in 1937, in carrying out the first successful excision of carcinoma of the head of the pancreas by this technique, modified the operation in some details (Fig 155, F), modifications which have since become standard procedures. He anastomosed the jejunum instead of the stomach to the gall-bladder, with an accompanying jejunostomy. This was intended to minimize or prevent the occurrence of cholangitis, which had been such a frequent complication of cholecyst-gastrostomy. Moreover, cholecyst-jejunostomy was much less of a technical handicap at the second operation than cholecyst-gastrostomy. Brunschwig further extended the resection in all directions. He removed the whole duodenum and the whole head of the pancreas, sectioning the latter through the neck. At about the same time a new and powerful impetus was given to this branch of surgery by the discovery of vitamin K by Dam (1935), by Quick's (1935) observation that prothrombin deficiency was the cause of bleeding, and by the realization that the

latter could be remedied by the former. This, coupled with a better understanding of shock and its prevention and treatment by blood and plasma transfusions, have contributed immensely in transforming a formidable and dangerous and consequently rare undertaking into a relatively safe and common one. Thus, in 1940, it became possible to carry out successfully radical pancreaticoduodenectomy in one stage. Whipple (1945) for carcinoma of the head of the pancreas, and Hunt (1940) for ampulla-papillary carcinoma (Fig 155, H). By April, 1942, at least 64 radical pancreaticoduodenectomies had been performed, and the time had come for a critical review of the results achieved. The main interest was now focused on the harmful effects of pancreatic exclusion. The

fistula, the common bile-duct should be anastomosed to the jejunum in one-stage resection, and its cut end should be tied and inverted with silk sutures or anastomosed to the jejunum in staged operations in which a cholecyst-jejunostomy is performed first.

At the time of writing no less than 125 cases of radical pancreaticoduodenectomy have been reported since 1935 (Orr, 1945, 104 cases, Cattell, 1945, 18 cases (5 included in Orr's report), Cole and Reynolds, 1945, 5 cases, and 3 personal cases reported here). The operative mortality has been 28 per cent. The best series of cases reported so far is that of Cattell (1945) who, during a two-year period (August, 1942–August, 1944), performed 17 radical pancreaticoduodenectomies (12 for carcinoma

Table II—OPERATIVE MORTALITY

	No of Cases	Deaths	Percentage
Transduodenal excisions (Hunt, 1941) —			
1898–1925	46	20	45
1925–1941	47	7	15
Radical pancreaticoduodenectomy —			
1935–1942 (Whipple, 1942)			
Two stage	41	12	29.2
One stage	23	8	34.7
1942–1944 (Orr, 1945)			
Two stage	15	4	26.6
One stage	19	6	31.5
1942–1944 (Cattell, 1945)	17	2	11.8

Table III—RESULTS OF PALLIATIVE BILIARY ENTERO-ANASTOMOSIS

Author	No of Cases Operated On	Operative Mortality	No of Cases Followed	Average Length of Life after Operation (mths)
Judd and Parker (1928)	34	47.0	12	7.7
Coller and Winfield (1934)	30	26.6	19	7.2
Fraser, Sir J. (1938)	211	51.84	140	*
Sallick and Garlock (1942)	50	48.0	25	6.3
Gray and Sharpe (1943)	11†	63.6	4	15.5

\* 66 per cent dead in less than six months, and the rest within a year, but during life a large percentage enjoyed freedom from pain and jaundice.

† All carcinomas of ampulla papillary region only.

Table IV—RESULTS OF LOCAL EXCISION OF AMPULLA-PAPILLARY CARCINOMA (After Hunt, 1941)

No of Cases Operated On	Operative Mortality Per cent	No of Cases Followed	Average Length of Life of Patient Dead when Reported	Average Length of Life of Patients Living when Reported
109	31.1	56	17.4 months (24 cases)	32.5 months (32 cases)

mortality of the operation had been 32 per cent (Whipple, 1942), and according to Cattell (1943) the commonest cause of death had been the development of internal pancreatic fistulae. A small number of deaths had been caused by bile peritonitis due to sloughing of the ligated end of the common bile-duct. Of 41 cases of radical resection reported by Whipple (1941), 8 developed an external pancreatic fistula and 5 a biliary fistula. The former closed spontaneously, but the latter often did not. Moreover, a proportion of patients developed some impairment of carbohydrate metabolism as shown by varying degrees of diabetes, and others, probably a third, had deficient absorption of fat and protein.

Owing to these complications, Whipple (1943) (Fig 155, I) and Cattell (1943) (Fig 155, J), decided to re-establish the flow of pancreatic juices into the intestine by anastomosis of the pancreatic stump, or duct if dilated, to the jejunum or stomach, and this has now become a routine procedure wherever possible. To prevent bile peritonitis and bile

of ampulla-papillary region, 3 for carcinoma of head of pancreas, 1 for carcinoma of duodenum, and 1 no carcinoma found) with two operation deaths (11.8 per cent) (1 dying of shock and anuria 24 hours after operation, and the other of pyelonephritis and pericarditis two months after operation). In all these the pancreatic stump was anastomosed to the jejunum, and resection was performed in two stages in 13, and in one stage in 4.

## PROGNOSIS

The immediate mortality figures for the various types of operation are given in Table II. It is noteworthy that Cattell's personal cases, in most of which the operation was performed in two stages, and included anastomosis of the pancreatic stump to the jejunum, should show such a low mortality. It is a most encouraging picture. There are as yet no comparative operation mortality figures for carcinoma of ampulla-papillary region and for carcinoma of pancreas.

The late results are known for palliative operations (Table III) and for localized transduodenal excision (Table IV), but it is as yet too early to judge the late results of the radical operation. When comparative studies are made, however, it will be necessary to take into account the fact that radical operations have been performed for both carcinoma of the head of the pancreas and carcinoma of ampullary region (Whipple, 1941), whereas the limited transduodenal excision was performed only for the latter group of carcinoma, the malignancy of which differs radically from that of the former. The localized nature and low malignancy of these ampullary growths is reflected in the long survival of so many cases following such a limited operation. Gordon Taylor (1942) and Brunschwig (1942) report 10 cases that lived over 5 years and 4 over 4 years.

cholecyst-jejunostomy was performed. The patient died the next day (Jan 15) from shock (?), two years and 10 months after local excision of tumour. Autopsy was not performed.

**Comment**—This was clearly a carcinoma arising from the duodenal papilla that had all the appearances of a simple papillomatous tumour, and thus induced one to perform a simple local excision. A radical pancreaticoduodenectomy should have been performed at the outset, or later, when the result of the histological examination

## CASE REPORTS

### Case 1—Papillomatous adenocarcinoma of ampullary region treated by simple transduodenal excision

Mrs A M, aged 71 years, admitted on March 3, 1943. First attack of painless jaundice 11 months before, which lasted 10 weeks, it was accompanied by some loss of weight, and then cleared up completely. Recurrence of painless jaundice two months before admission, with pale stools and bile in urine. Slight loss of weight, but patient had gained some weight following the first attack of jaundice.

**ON EXAMINATION**—A thin and tired and deeply jaundiced woman. Liver edge palpable 1 in below costal margin. Gall-bladder dilated and palpable. Serum bilirubin, 6 mg per cent. RBC, 3,510,000 per cmm. Hb, 62 per cent. Prothrombin index, 73 per cent.

Vitamin K and blood transfusions given before operation.

**OPERATION** (March 12)—*Transduodenal excision*. The liver was enlarged and bile-stained. The gall-bladder and bile-ducts were grossly dilated and contained 'white bile'. The second part of the duodenum contained a papillomatous-like tumour. The duodenum was mobilized and opened over the tumour, which was a narrow pedicle from the papilla of Vater. There was no induration around the pedicle, or other indication of malignancy. The tumour was excised by cutting through the tissues around the base of the pedicle. The papilla of Vater was thus excised with the tumour, a small depression being left, in which the cut ends of the common bile-duct and pancreatic duct were visible. These were stitched to the margins of the defect in the posterior duodenal wall (see Fig 156). The anterior duodenal wall was closed and the common bile-duct drained by an indwelling tube put into its supraduodenal portion, and the operation completed.

**PATHOLOGY**—The tumour was a soft, fleshy papilloma 1½ in in diameter, with a short narrow pedicle surrounded by a narrow rim of duodenal tissue (Fig 156). Histologically it was a malignant adenocarcinoma, probably arising from the duodenal papilla. There was no invasion of the excised duodenal tissue.

**PROGRESS**—The patient made a rapid recovery, jaundice cleared, she gained weight and strength, and remained in good health for two years and six months. In November, 1945, she began to lose weight, a hard mass developed in her epigastrium and increased in size. No jaundice. Laparotomy in January, 1946, confirmed the presence of a local recurrence in the head of the pancreas which was irresectable owing to invasion of the superior and inferior mesenteric veins. No secondaries were found. A posterior gastrojejunostomy and

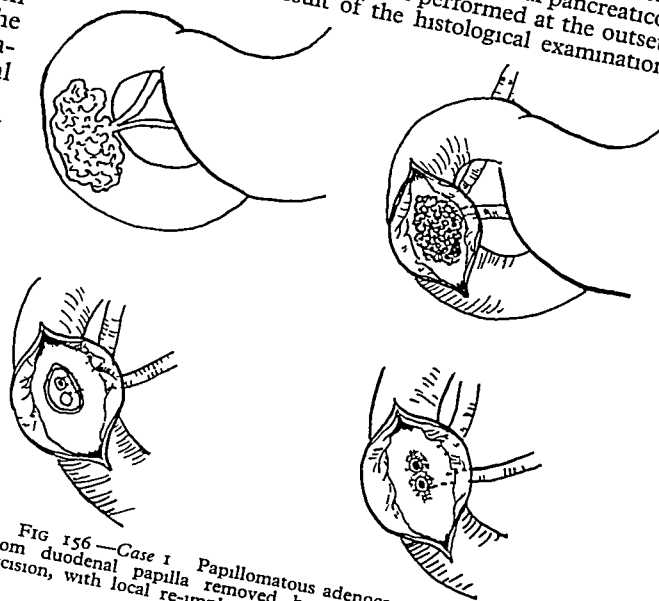


FIG 156—Case 1. Papillomatous adenocarcinoma arising from duodenal papilla removed by simple transduodenal excision, with local re-implantation of the ducts.

became known. It is noteworthy that the recurrence was purely local and might have been removable if the patient had presented herself earlier. Other interesting features in this case were the two attacks of jaundice separated by an interval of 7 months, during which the patient was perfectly well and even gained weight.

### Case 2—Adenocarcinoma of the head of pancreas treated by one-stage radical pancreaticoduodenectomy

Mr J J W, 70 years, admitted April 4, 1945. Pain in right hypochondrium for one month. Jaundice, 15 days, pale stools and dark urine, 7 days, some loss of weight.

**ON EXAMINATION**—A thin and slightly wasted man, with slight jaundice. Liver not palpated, gall-bladder distended and palpable. RBC's 4,300,000, Hb 78 per cent. Serum-bilirubin 4 mg per cent. Prothrombin index 80 per cent. Hippuric acid test, normal.

A provisional diagnosis of carcinoma of pancreatic head was made on the clinical finding of dilated gall-bladder.

**OPERATION** (April 24), under spinal anaesthesia—*One-stage radical pancreaticoduodenectomy, with pancreatic excision*. Hard mass localized to head of pancreas, with distended common bile-duct and gall-bladder. Slight enlargement of the liver. No secondaries detected. The head of pancreas and duodenum were easily mobilized. There was no invasion of the portal or the superior mesenteric vein. The stomach was divided across the pyloric antrum, the pancreas was then removed, neck, and the jejunum about 3 in from the duodenum and head of pancreas was then removed, after final separation from the portal vein and superior mesenteric vessels. The pancreatic duct was ligated with silk, and the stump closed with interrupted silk sutures. The cut ends of the stomach and jejunum were

then anastomosed, and the cut end of the common bile-duct implanted into the side of the jejunum 12 in distant from the gastrojejunal anastomosis (Fig 157). A drain was placed down to the pancreatic stump, and the abdomen closed.

**PATHOLOGY (Fig 158)**—"A whole section to include the wall of the duodenum and the whole portion

one stage. There was satisfactory digestion and absorption of fat and protein. Death 9 months later from carcinomatosis.

**Case 3—Adenocarcinoma of the head of pancreas treated by radical pancreatico-duodenectomy (One-stage) with pancreatico-jejunostomy**

Mr D W, aged 52, admitted July 18, 1945. Severe diarrhoea lasting a fortnight 7 weeks before admission, jaundice for 3 weeks, increasing in intensity, recurrence of diarrhoea with pale offensive stools one week before admission. No pain. Moderate loss of weight.

**ON EXAMINATION**—A thin, emaciated and moderately jaundiced man. Liver edge  $1\frac{1}{2}$  in below costal margin. Palpable enlargement of gall-bladder, and hard mass in region of head of pancreas. R B C 4,800,000 per cmm. Hb 90 per cent. Serum-bilirubin 4.8 mg per cent. Prothrombin index 70 per cent. Hippuric acid test normal.

Provisional diagnosis of carcinoma of head of pancreas.

**OPERATION (July 24)**—Under spinal anaesthesia. One-stage radical pancreatico-duodenectomy with pancreatico-jejunostomy (Whipple, 1943 technique. See Figs 155, 1, 159, A). The liver was a little enlarged, the common bile-duct and gall-bladder markedly so. There was a small hard mass localized to head of the pancreas. No secondaries detected. The portal and superior mesenteric veins were free. The duodenum

of excised pancreas shows a fairly well-differentiated adenocarcinoma of the pancreas of the scirrhous type. The uninvaded portion of the pancreas shows a good deal of cirrhotic change. The growth has invaded the mucosa of the duodenal wall beyond the muscularis mucosae. No lymph-nodes were available for section."

**PROGRESS**—The immediate post-operative stage passed without incident. The abdomen healed by primary

FIG 157—Case 2. One stage radical pancreatico duodenectomy with pancreatic exclusion

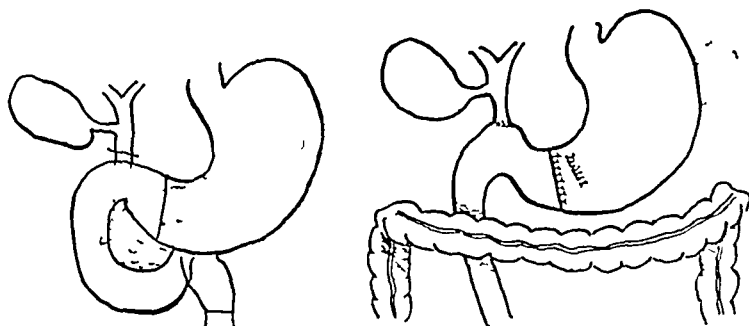
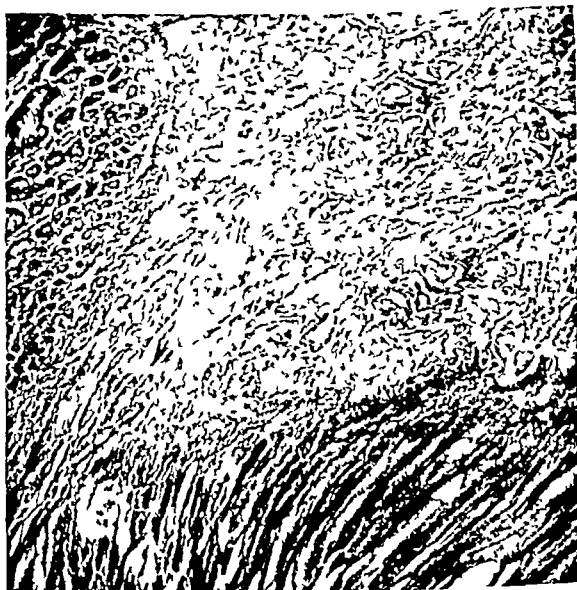


FIG 158—Case 2. Scirrhous adenocarcinoma of head of pancreas invading the duodenal wall ( $\times 35$ )



B

union. Jaundice cleared, the patient gained weight and left hospital three weeks after operation. Carbohydrate metabolism and fat absorption were not disturbed. Six months after operation, the patient developed acute pyelitis. From then on his general condition deteriorated, secondary nodules appeared in the abdominal wall and he died 9 months after his operation from carcinomatosis. A post-mortem examination was not performed.

**Comment**—A case of scirrhous adenocarcinoma of the head of the pancreas successfully removed by radical pancreatico-duodenectomy with pancreatic exclusion in

and head of the pancreas were easily mobilized. The stomach was divided across the pyloric antrum and the common bile-duct above the duodenum. The pancreas was divided across its neck, the line of section being  $1\frac{1}{2}$  in distant from the visible edge of the growth. The pancreatic duct was dilated, having a diameter of  $\frac{3}{4}$  in. The jejunum was divided 4 in from the duodenojejunal junction. The growth-containing mass was then separated from the portal vein and superior mesenteric vessels, and removed. The cut end of the jejunum was anastomosed to the cut end of the common bile-duct. The dilated pancreatic duct was then anastomosed to the



side of the jejunum descending from its junction with the common bile-duct. Lower down the cut end of the stomach was joined to the side of the jejunum. The abdomen was closed without drainage.

**PATHOLOGY**—"A section to include the whole head of the pancreas and adjacent duodenal wall shows a well-differentiated Grade 1 adenocarcinoma of the pancreas with marked scirrhous reaction (Fig 159). The growth is just invading the submucosa of the duodenum but no farther. The growth, however, reaches the excision end, and may not have been completely removed."

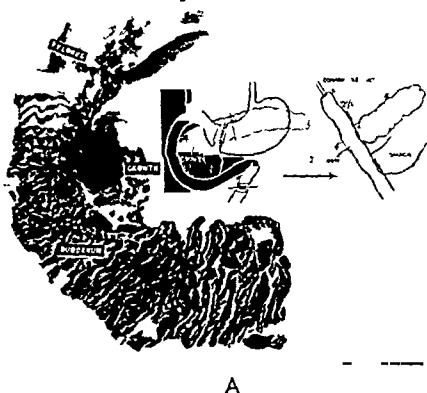


FIG 159—Case 3. Scirrhous adenocarcinoma of head of pancreas

**PROGRESS**—In the immediate post-operative stage recovery was slow but steady. Jaundice cleared up, healing of wound *per primam*. Carbohydrate metabolism has been normal, the patient can tolerate and digest and absorb normal quantities of fat, but excessive intake immediately leads to the passage of 'oily' stools. He has gained weight and strength and is now back at his old job of house decorator and painter.

**Comment**—Section through the neck of the pancreas seemed to be  $1\frac{1}{2}$  in. away from the near edge of the growth in the head, and yet the pathologist reports that the growth reaches the site of excision. This suggests the advisability of sectioning the pancreas farther to the left, through the body, as a routine measure in cases of carcinoma of the head.

#### Case 4—Adenocarcinoma of the head of the pancreas treated by a two-stage radical pancreatico-duodenectomy

Mr H B, aged 43, admitted on Sept 21, 1945. Previous history of chronic gastric ulcer for which a partial gastrectomy with short loop post-colic anastomosis had been performed on Oct 25, 1943. Present history of rigors for 6 weeks accompanied by increasing jaundice and pain in right hypochondrium. Some loss of weight. Pale stools and dark urine.

**ON EXAMINATION**—Marked jaundice, little wasting. Tender and enlarged liver. Gall-bladder was not palpated. RBC, 4,900,000. Hb, 17 g per cent. Serum-bilirubin, 6 mg per cent. Van den Berg test, biphasic reaction. Hippuric acid test, poor excretion. Prothrombin index, 26.2 per cent. Prothrombin response to injection of vitamin K was prompt. Urine showed no excess of urobilinogen.

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The picture was that of obstructive jaundice. Owing to the patient's poor general condition, operative treatment, if possible, should be staged.

**FIRST OPERATION** (Oct 5, 1945)—Under nitrous oxide, oxygen, and ether. **Cholecystomy**. The liver was markedly enlarged, the gall-bladder and bile-ducts were dilated, and the former was tucked away under the liver. There was a hard nodule about  $1\frac{1}{2}$  in. in diameter in the head of the pancreas. There were no secondaries, the duodenum and head of the pancreas were easily mobilized and the veins appeared free. But



B

the patient was in no fit state to stand a big operation. Cholecystostomy was done in favour of cholecyst-jejunostomy. Parenteral vitamin K was given. Recovery was rapid and the patient gained weight.

**SECOND OPERATION** (Oct 22—3 weeks later)—Under spinal anaesthesia. **Radical pancreatico-duodenectomy**. The liver had shrunk to almost normal size. The pancreas was now generally enlarged and turgid, and the growth appeared to have invaded the whole head of the gland. All the neighbouring tissues were engorged with blood and the veins stood out. A radical excision of the head of the pancreas and duodenum was indicated, but obviously fraught with difficulties. After mobilization of the duodenum and head of the pancreas, the neck of the pancreas was cut across. The duodenum was then divided just to the right of the superior mesenteric vessel, and the cut end of the distal portion invaginated. On separating the head from the portal vein, the latter was torn and serious haemorrhage occurred. The rent was eventually repaired by suture. Further separation led to more bleeding, so that eventually a narrow cuff of the head of pancreas had to be left *in situ* around the portal vein. The common bile-duct was divided and its end ligated and invaginated. By this time the patient's general condition was so poor that the operation had to be terminated quickly. The pancreatic stump was stitched, and the cholecystostomy was not disturbed. The continuity of the intestinal tract was, of course, assured by the previous partial gastrectomy. A drainage tube was put down to the pancreatic stump, and the abdomen closed.

**PATHOLOGY**—"A whole section shows a Grade 2 adenocarcinoma of the pancreas invading the submucosa of the duodenum (Fig 160). The papillomatous



growth in the ampulla and projecting into the duodenum through the orifice of the common bile-duct is a benign papilloma and does not appear to have any connexion with the carcinoma of the pancreas"

**PROGRESS**—The immediate post-operative period was stormy. The patient developed a pancreatic fistula,

and bile-stained. The gall-bladder was congenitally absent, and common bile-duct dilated. Some enlarged lymph-nodes were present along the upper border of the body of the pancreas. The diagnosis was in doubt, and it was judged that a choledcho-jejunostomy and time would settle the diagnostic problem, and serve as a



A

FIG 160—Case 4. Scirrhus adenocarcinoma of head of pancreas and simple papilloma of ampulla of Vater



B

which persisted for one week. Then signs of generalized acute peritonitis developed and the patient died from this 12 days after operation. A post-mortem examination was not made.

**Comment**—It is the considered opinion of an experienced pathologist, who examined this specimen, that the papilloma of the ampulla was simple and that it bore no relationship to the adenocarcinoma of the head. Such an occurrence must be very rare indeed, and I know of no published report of a similar case.

Death in this case was indirectly caused by a pancreatic fistula, a complication which once again emphasizes the absolute necessity of anastomosing the pancreatic duct to the alimentary tract.

The extraordinarily rapid progress of the growth during the three weeks following the first operation caused some surprise and dismay at the second operation. Such a development is unfortunately not uncommon, and always leaves one in doubt as to how much of it is due to handling of the growth and disturbance at the first operation.

#### Case 5—Chronic pancreatitis simulating carcinoma of the head of the pancreas

Mr A B, aged 59 years, admitted July 10, 1944. History of painless progressive jaundice for 6 weeks, with clay-coloured stools and dark urine. Some loss of weight, but good appetite.

**ON EXAMINATION**—Little wasting, marked jaundice. Liver and gall-bladder not palpable. R B C, 2,010,000 per c mm. Hb, 44 per cent. W B C, 22,000. Blood-bilirubin, 3 mg per cent. Hippuric acid test normal. Prothrombin index, 73 per cent. Satisfactory and prompt prothrombin response to parenteral injection of vitamin K.

Five pints of blood were given to combat anaemia, and pre-operative vitamin K daily.

**OPERATION** (July 24)—Under ether anaesthesia. Choledcho-jejunostomy. Both head and body of the pancreas were hard and swollen. The liver was enlarged

first stage to resection if the lesion should prove to be carcinomatous. The common bile-duct was divided above the duodenum, the lower end tied, and the upper end anastomosed to the jejunum, which was brought up in front of the transverse colon and omentum.

**PROGRESS** was satisfactory and rapid, jaundice cleared, and the patient began to gain weight and strength. A second operation was advised, but the patient refused to consider it.

He has now been at work for over a year, has gained more weight, and he is well, his appetite is good, and he can eat anything, including fatty foods. Examination of the abdomen on three occasions since operation has failed to reveal any abnormality.

Biopsy of a pancreatic lymph-node showed chronic inflammatory changes only.

**Comment**—This was clearly a case of subacute or chronic pancreatitis completely simulating carcinoma, which cleared up after internal biliary drainage. It serves to illustrate the importance of performing the operation of radical pancreatco-duodenectomy in two stages in all cases in which the diagnosis of carcinoma is in doubt.

#### OTHER CASES

During the same period under review (1942-5, inclusive), the following additional cases were observed: 8 cases of carcinoma of the head of the pancreas (not confirmed histologically), 2 of the body, and 1 of the head and body. Of these only 2 cases of carcinoma of the head were operable, one died of liver failure 5 days after cholecyst-jejunostomy, and the other refused to submit to resection after preliminary cholecyst-jejunostomy and died 5 months later. A clinically palpable gall-bladder was found in 50 per cent of the cases with jaundice, which was present in 6 of the 8 cases of carcinoma of the head. In the remaining 2 cases the presenting feature was vomiting due to duodenal obstruction by growth. In all cases except 2, abdominal pain was a prominent feature, preceding the onset of jaundice.

# PANCREATIC AND BILIARY TRACT SURGERY

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## SUMMARY

A short review of recent advances in the diagnosis and treatment of carcinoma of the head of the pancreas and ampulla-papillary region is presented.

The incidence of these tumours, and the difficulties and method of diagnosis are discussed. The evolution of surgical methods of treatment is traced from 1898 to the present, and an evaluation of present-day methods is made.

Detailed reports of 5 cases are given. One tumour, an adenocarcinoma arising from the papilla of Vater, was simply excised by the transduodenal route. Three carcinomas of the head of the pancreas were excised by radical pancreatectomy with one post-operative death. A case of chronic pancreatitis simulating carcinoma of the head of the pancreas is included to emphasize the diagnostic difficulties.

**Acknowledgements**—Many of my colleagues have contributed in the investigation and treatment of these cases, and to them I am deeply grateful. I am especially indebted to my medical colleague, Dr A P M Page, to Dr L C D Hermitte, who has been untiring in his efforts with the reproduction of reports on the specimens, and to Dr Justin Davies, who gave the anaesthetics so skilfully. Finally, to the nurses and sisters in the wards and theatre it is a pleasurable duty to express my deep appreciation of their work and unstinted help.

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## THE EXCISION AND REPAIR OF DEEP THERMAL NECROSIS

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THE surgical excision of tissues irreparably damaged by heat has been advocated for a considerable time (Wilms, 1901, Willis, 1925, Mason, 1941, Young, 1942), but the method has several limitations which may have prevented its practice in suitable cases.

In theory, the sooner a devitalized area is separated from its host, the sooner will surgical repair be practicable and the shorter the stage of toxic absorption from the infected slough. This is generally accepted, but we have found less support for our opinion that the corollary of this statement is that, whenever possible, excision of the entire area should be carried out before proteolysis occurs and should be immediately followed by primary repair. In most cases such repair can be adequately effected by split skin-grafts providing these will have a vascular bed for their reception, exposed tendons or cortical bone, for example, cannot support any thickness of free graft whatsoever, their failure over such areas will result in further infective necrosis.

For primary excision to be practicable, the following must be fulfilled (1) The area of necrosis must be capable of total excision (2) The area to be excised must not be surrounded by an area of partial-thickness skin loss (3) Facilities for immediate repair of the area must be available.

To consider these items in detail —

1 *The Area of Necrosis must be capable of Total Excision*—Although partial excision of the slough may diminish the degree of infective toxæmia, it is of limited value in that epithelialization will be delayed until separation of the remaining slough has occurred. The more common difficulty, however, is the determination of whether or not deep epithelial elements have survived. We consider that if the other criteria can be fulfilled, the sacrifice of a few sweat glands and hair follicles is of no importance. In a large burn where, possibly, not more than 10 per cent of the deep elements are viable, the rate of healing from these survivors is so slow as to be valueless, scar contracture will occur in the intervening areas, producing, ultimately, delay in epithelialization and probable deformity. It is the difficulty of estimating the proportion of surviving elements which limits the field for early surgery, this is in no way simplified by the knowledge that a proportion of those surviving the original heat necrosis will fail to survive the infective phase. The use of picro-fuchsin to determine the proportion of viable structures in a burn has been investigated by Patey and Scarff (in 1944). We have had no experience of this method, nor of the use of fluorescein, which has been used by American workers. Neither of these methods gives any estimate of which cells will fail to survive the infective phase, and it is clear that this is entirely a matter of chance.

2 *The Area to be excised must not be surrounded by an Area of Partial-thickness Skin Loss*—Although

we have excised areas of full-thickness skin loss, when surrounded by a more superficial loss, we do not consider this a valuable technique unless performed in the second or third week, when the area of slough is clearly demonstrable. The grafting of such defects is hazardous, as the inevitable infection of the surrounding areas will tend to diminish the percentage take of the graft.

We regard this as one of the most important criteria to be fulfilled before early operation upon a thermal burn is contemplated.

3 *Facilities for Immediate Repair of the Area must be available*—Immediate repair of the defect will, in most cases, mean the use of partial-thickness skin-grafts immediately following the excision. Any delay, even for a few days, between the two parts of the operation may permit local sepsis to occur, and will allow the development of scar tissue in the recipient areas. Even with the aid of chemotherapy it is preferable to graft a recent surgical wound rather than granulations, however admirable (Rank, 1940, Mowlem, 1941, 1944).

Other factors bear upon the question of immediate repair, the availability of adequate donor areas for the split skin-grafts and the technical equipment of the surgeon to cut these grafts without risk of damaging important donor areas, are but two essential requisites.

While these three criteria are, clearly, not absolute, when they occur together we consider that the early excision and immediate repair of an area of complete thermal destruction should be considered.

The case quoted to illustrate this active approach cannot be considered as typical of the type of loss suitable for surgery, nevertheless, we find it difficult to believe that any other method of treatment would, in the presence of such extreme destruction, have enabled the patient to stand upon her own limbs two months after injury.

## CASE REPORT

Jan 4, 1945 Mrs B, aged 47, was blown by the explosion of a V2 bomb into her own fire and was pinned by masonry for 3 hours in more or less direct contact with the embers.

Jan 6 Transferred to an E M S Plastic Unit Condition on admission good, comfortable and uncomplicating (Fig 161).

The right leg had been burnt around the circumference of the distal half of the thigh and proximal half of the leg. Diagnosis of the depth of the burn was complicated by the liberal application of gentian violet dye prior to admission.

The left leg showed an extreme degree of heat coagulation, the muscles of the thigh and calf on the lateral aspect were grey and quite friable and had the appearance of slowly-cooked meat.

Jan 12 OPERATION Necrotic skin was removed from the lateral and posterior aspects of the thigh from the gluteal fold to the popliteal fossa. In the leg, the skin of the upper two-thirds of the posterior and antero-lateral aspects was excised, together with that over

the upper two-thirds of the subcutaneous border of the tibia

In the thigh the lateral half of the biceps was removed, while in the leg the upper two-thirds of the muscles in the antero-lateral compartment were excised completely,



FIG 161—(Jan 6, 1945) Condition on admission, showing the black necrotic skin with muscle protruding in the calf

as were the peroneal nerve and the lateral half of the calf muscles. All these structures were quite necrotic.

Operation was then terminated, as the patient's general condition was deteriorating and the circulation of the foot had suffered when the anterior tibial artery had been tied, as it perforated the interosseus ligament.

It was known that all necrotic tissue had not been removed at this operation and that many areas, though not necrotic, were markedly affected. Further ablation was clearly necessary as the upper two-thirds of the fibula, its interosseus membrane, and the anterior half of the tibia were exposed and would sequestrate.

Penicillin-sulphonamide powder was insufflated on the wound, a pressure dressing applied, and the limb immobilized in plaster.



FIG 162—(Jan 24) After excision of avascular skin and muscle. Tibia and fibula exposed

An interesting note on the pathology of heat necrosis was the marked absence of bleeding from veins, although arterial pulsation was undiminished. In some areas (the upper half of the anterior tibia, for example) the local arteries ran apparently unscathed through muscle so friable that it could be removed with the finger.

Jan 14 Post-operative condition satisfactory.

Jan 16 Suddenly, after complaining of severe pain in the foot, the patient became quite irrational, with pyrexia, marked tachycardia, and a raised respiratory rate. 1½ pints of blood were given, with improvement.

Jan 17 OPERATION. Further small areas of slough were removed, mainly fascia. Some muscle bundles in unopened and apparently viable fascial sheaths were, in fact, found to be necrotic. These were excised. In the peroneal region clean granulations were present over a small area. Dressing as before.

Jan 22 Considerable improvement following operation. Toxic facies no longer present.

Jan 24 OPERATION. At least 95 per cent of the area was found to be covered with clean granulations. The remaining 5 per cent consisted of odd tags of sloughing fascia, skin, and muscle. These were removed. The cortex of the antero-medial and antero-lateral aspects of the tibia in its upper two-thirds, together with the crest and most of the tibial tubercle, was

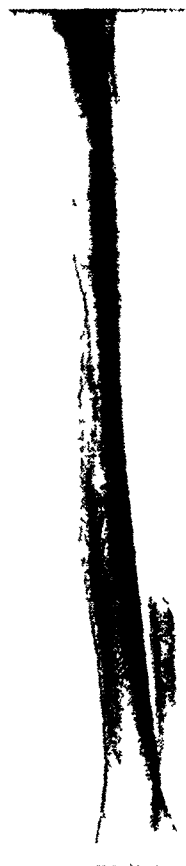


FIG 163—(Feb 10) Radiograph showing the amount of tibia and fibula removed

removed by hammer and chisel to expose the medulla. The upper two-thirds of the fibula and interosseus membrane were removed. Strips of thin split-grafts cut from the abdomen were used to cover most of the leg and a small area of thigh. Pressure dressing and plaster fixation. Neither penicillin nor sulphonamide powder was used. (Fig 162)

Feb 2 OPERATION. Further cortex was removed from the tibia, the amount removed at the previous operation being inadequate in that none of the grafts over this area had survived and granulations were scanty and of poor quality. 50 per cent of the grafts used at the previous operation appeared to have survived. Granulations between these grafts were clean and of good texture. Further grafts were cut from both thighs to give about 30 per cent cover over the calf and 75 per cent over the thigh.

Feb 16 OPERATION. Further grafts, cut from the back, were used to cover the remaining defects. Grafts from previous operation 100 per cent. (Fig 164)

Feb 27 Left leg almost completely healed, areas remaining unhealed being of no significance. Afebrile for one week. Started to get up, legs very weak, but without deformity of knee or ankle. General condition excellent. This was 7 weeks after injury.

The patient has since been seen on various occasions. She walks well with a stick and a toe spring to make good the loss of the muscles of the anterior tibial and peroneal groups. Foot-drop has not occurred owing to the fixation of the distal muscle stumps by scar tissue, because of this there is only a few degrees of plantar flexion, passive dorsiflexion full. Oedema of the foot is controlled by a crêpe bandage, sensation on the sole normal. Knee flexion  $75^{\circ}$ . No further surgery required.



FIG 164—(Feb 16) After grafts had been used on two occasions to cover the defects

**Comment**—Three further points of interest arise from this case, first, that the only occasion in which the patient was severely ill, or suffered toxæmia in any way comparable to the magnitude of the burn, occurred when the surgical treatment was inadequate, and was relieved by further surgery.

Secondly, that chemotherapy was used on two occasions only and that on the first of these it could not compensate for inefficient surgical treatment. Penicillin in this type of case should be used locally in conjunction with surgery, systemically, should a cellulitis or lymphangitis develop as a result of surgery.

Thirdly, attention is drawn to the variable sites of donor areas for the split-skin grafts. At no time was the repair delayed by lack of available donor areas.

In this case it will be noted that immediate repair of the area was not performed. This was because the extreme degree of loss made total excision of the affected area at one operation impossible.

### SUMMARY

1 The early excision and repair of thermal burns involving destruction of all layers of the skin is discussed.

2 The circumstances in which this is the method of choice are itemized.

3 An illustrative case is described.

4 The word 'burn', when used in this paper, is used for lack of a suitable alternative. We consider

the mechanism of tissue death, whether it be traumatic, chemical, thermal, or electrical, to be of academic interest only, our surgical interest must be toward the repair of the loss.



FIG 165—(April 11) Final condition of leg. Walking well with toe spring. Scars surrounding the graft are hypertrophic, but already subsiding. No further treatment required.

My grateful thanks are due to Mr Rainsford Mowlem, Surgeon-in-Charge, Plastic and Jaw Unit, Hill End Hospital, St Albans, for advice and assistance.

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## RECONSTRUCTIVE SURGERY OF THE HAND

### WITH SPECIAL REFERENCE TO DIGITAL TRANSPLANTATION

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THE experience gained while in charge of the Hand Clinic at Leith Hospital during the past four years has convinced me that, if the ideal of treatment is to be approached, there must be continuity in a single unit. In dealing with a mutilating injury of the hand, the full treatment which may be required can be divided into five aspects: primary reparative surgery, physiotherapy, reconstructive surgery, restoration of maximal function, and vocational training. These aspects are not clear-cut, nor does the need for each exist in every case. The present paper deals only with the stage of reconstructive surgery.

#### METHODS OF RECONSTRUCTION

Crippled hands following severe injury fall into two main groups: those in which structures are present but lack function, and those in which structure has been reduced to a functionless level, as when all digits have been lost.

In the first of these, it is usually apparent to both the patient and the surgeon that something should be done to improve matters; in the second, it is not so obvious, and there may be a danger of such unfortunate patients being allowed to leave hospital without having been fully treated, to struggle along as best they can. It is not the purpose of this paper to go into the intricacies of the procedures which may be employed to restore function to the functionless digit, but to demonstrate that much can be done for the second type of case—that is, where insufficient functional units remain.

The essential anatomical structures which subserve the basic function of the hand are two digits capable of being brought into opposition with each other, in other words, a thumb and one finger. There is little to choose between a hand which has a thumb but no opposing finger and one which consists of four fingers but no thumb; the function of both has been very considerably reduced. The aim in reconstruction should be to restore to these mutilated hands at least the basic finger-thumb combination, and to achieve this aim it is obvious that one missing digit must be replaced. To restore a digit to the site of one which has been lost, three methods are available: first, the transposition of one of the remaining digits of the same hand; secondly, a whole finger graft from the other hand (a toe has been used quite successfully, but there can be little doubt that a finger gives the better functional result); and, thirdly, the manufacture of an artificial finger from living tissues. The transposition of a finger from the same hand has its main use in restoring the loss of a thumb—a further rather unique use is described below. A whole-finger graft from the uninjured hand finds its main field in the case of total loss of all four fingers. The third procedure

—plastic construction of a finger of the fixed prop type—has several disadvantages: mobility is absent, sensation is absent or only partly present, viability of the finger is somewhat precarious and the partially insensitive finger is liable to be injured or burned. The time spent in its construction is longer than that for the other methods, more operative stages are required, and at least two additional scars are made. With these disadvantages, it is preferable, if possible, to use either of the first two methods. In cases where this is not possible, the third method is indicated, and patients who have undergone this type of reconstruction have been very grateful.

Six cases are reported: two examples of each of the three methods of reconstruction.

#### CASE REPORTS

##### TRANSPOSITION OF A FINGER OF THE SAME HAND

*Case 1*—J. R., aged 21. This man had his thumb avulsed in a rope-making machine. The base of its metacarpal remained and the carpo-metacarpal joint was uninjured (*Fig 166*).



FIG 166—*Case 1* Showing total loss of left thumb

**OPERATIVE TECHNIQUE**—Incisions were made on the palmar and dorsal aspects of the hand, similar to those for a syndactyle. First, the digital nerve and artery to the adjacent sides of the index and middle fingers were exposed from the palmar aspect. In order that the index finger could be widely separated from the rest of the hand without damaging or destroying its nerve or arterial supply, the palmar digital nerve was split from its bifurcation to its origin from the median, and the branch of the palmar digital artery to the radial side

of the middle finger was divided between ligatures (*Fig 167*). On the dorsal aspect, an oblique band joining extensor indicis to the extensor of the middle finger was divided at the lower margin of the extensor retinaculum.

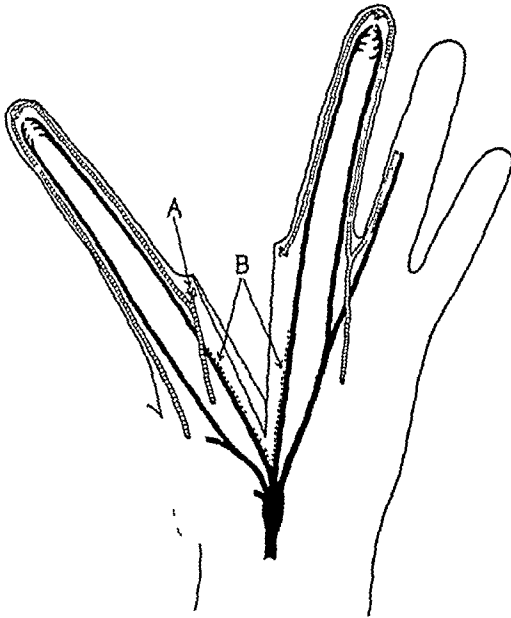


FIG 167—Same case. Illustrating method of maintaining bilateral nerve and arterial supply. A, Division of digital artery to radial side of middle finger. B, Split portion of palmar digital nerve, indicated by interrupted line.

The second metacarpal with its periosteum was then sectioned  $\frac{1}{2}$  in from its base, care being taken not to injure the radialis indicis artery. The dissection was resumed on the palmar surface, and access to the cellular plane between the palmar and dorsal interosseous muscles was gained after dividing the transverse carpal ligament. The palmar interosseous muscle was separated and retracted to expose that portion of the second dorsal interosseous muscle arising from the ulnar side of the second metacarpal. This origin was stripped from the bone. The index finger was now completely

separated from the rest of the hand as far as the base of its metacarpal. It was structurally intact in so far as it had a bilateral nerve and arterial supply, flexor and extensor tendons, its lumbrical and interossei. The whole unit was then moved radially, rotated through  $90^\circ$ , and fixed by suturing the second metacarpal to the stump of the first metacarpal. Next, the distal end of the extensor tendon was sutured to the stump of extensor pollicis longus.

The wound was closed by suturing the dorsal flap round the third metacarpal and bringing the palmar flap round the new thumb. This flap was not long enough to close completely the gap and a small skin-graft was applied. An amputation through the proximal interphalangeal joint of the transposed digit was then performed. *Fig 168* shows the final result.

*Case 2*—A C, aged 14 $\frac{1}{2}$ . This boy caught his right hand between the rollers of a baking machine, and sustained a 'degloving' injury. The skin had been divided 1 in above the proximal flexion crease of the wrist, and turned inside out to the level of the metacarpophalangeal joints.

#### OPERATIVE TECHNIQUE—

1 *Initial Operation*—This operation was performed within three hours of the injury. After the usual surgical toilet, all fat was excised from the skin-flap, which was then replaced and sutured in position as a full-thickness pedicle graft. Several small incisions were made for the purpose of drainage, and a pressure dressing was applied, but later the whole of the graft sloughed, and the index, ring, and little fingers became gangrenous (*Fig 169*). This gangrene was ischaemic in nature and was probably due to arterial thrombosis following trauma to the main vessels. Though not all of the middle finger died, necrosis and separation of the whole of the proximal phalanx occurred, leaving the finger attached by a small soft-tissue pedicle containing one digital artery.

2 *Skin-grafting*—A tubed pedicle graft was raised from the skin of the right iliac fossa, in an oblique direction from the anterior superior iliac spine towards the left shoulder. All dead tissue was excised from the hand, which was treated in closed plasters till a healthy granulating surface was obtained.

Five weeks later the distal end of the pedicle was detached from the abdomen, opened out, and applied



FIG 168—Same case. Showing hand after transposition of index finger to site of missing thumb with amputation of distal two phalanges.

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to the dorsal surface of the wrist, the free end being sutured to the proximal skin edge. At the same time, the tube was extended towards the costal margin. Two weeks later the extended portion of the pedicle was raised and applied to the dorsum of the hand, and a further

middle finger had lost only its proximal phalanx. The index finger had lost all but its proximal phalanx. The middle finger was incapable of movement owing to the loss of its interossei and lumbrical attachments and the destruction of its long tendons. The index stump was capable of movement by virtue of its lumbrical, interossei, and long tendons which were adherent to the proximal phalanx (Fig 171, A). It was reasoned that, if the remnants of these two fingers could be combined, one whole and functioning digit would result.

## 3 The Reconstruction —

**Middle finger** A triangular incision, its apex distally, was made on the radial side of the proximal phalanx and the enclosed area of skin excised. An accommodation space was made in the fibrous-tissue core of the finger, extending distally to the base of the middle phalanx. The whole of the middle metacarpal was then excised through a separate incision on the dorsum of the hand.

**Index stump** The whole of the skin and subcutaneous tissue was excised with the exception of an inverted V-shaped area on the radial side. Fibrous tissue was cleared from the end of the phalanx till healthy bone was exposed.

The middle finger was moved towards the radial side till the proximal phalanx of the index finger occupied its accommodation space. This lateral shift was made partly by the mobility of the soft tissues and carpal towards the bed of the excised third metacarpal (Fig 171, B). The proximal phalanx of the index finger was then sutured with catgut to the second phalanx of the middle finger. The margins of the two skin incisions



FIG 169 —Case 2 Seven days after injury the necrotic skin has been cut away. Dry gangrene of index, ring and little fingers, most noticeable at nails.

extension of the tube over the costal margin was carried out. At the end of a further two weeks, the pedicle was detached from the chest and carried over the metacarpal heads to cover the distal portion of the palm. Three weeks later, a split-skin dermatome graft was used to cover the remaining raw area of the palm and wrist.



FIG 170 —Same case After completion of skin grafting the dorsum and distal portion of palm are covered by an abdominal pedicle graft, the wrist and proximal portion of palm with a split-skin graft. The middle finger is flail and lying towards the ulnar side.

By the time healing was complete, the thumb had become somewhat adducted and a flexion deformity of the wrist was present. The middle finger maintained its viability, but it was flail and without active movement (Fig 170).

After a period of physiotherapy, during which time movements of the thumb and wrist improved, the reconstruction of a 'forceps hand' was undertaken. The

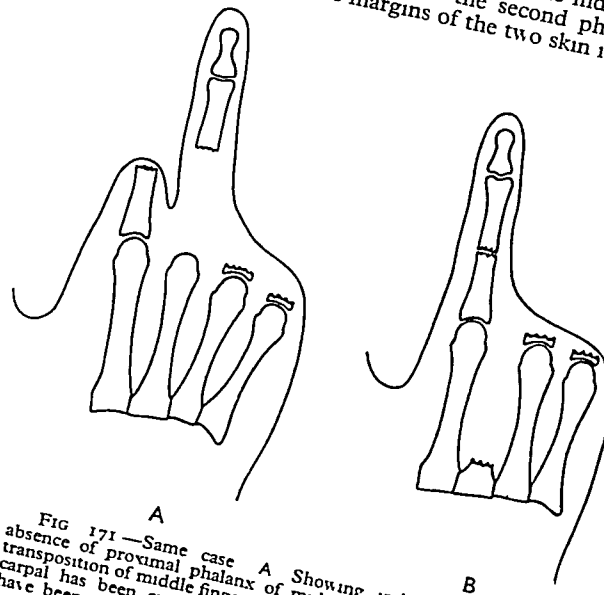


FIG 171 —Same case A Showing index stump and absence of proximal phalanx of middle finger. B Showing transposition of middle finger to index site. The middle metacarpal has been excised. The fourth and fifth metacarpals have been moved towards the radial side.

which had now come together were sutured and plaster-of-Paris fixation employed.

**4 Further Operative Procedures** —Three months after operation no bony union had occurred. Following a further operation at which the bone ends were freshened and sutured with stainless steel wire, firm union occurred in six weeks. As there was still considerable adduction



of the thumb and flexion of the wrist, a Z-plastic of the first interdigital cleft and lengthening of the flexor tendons in the wrist were carried out. At the same time, the rather voluminous abdominal graft was under-cut, trimmed, and re-sutured. Fig 172 shows the result six months after the completion of this operation.



FIG 172—Same case. Showing result of transposing middle finger to site of index.

**Comment**—Both these patients are now fully employed. J. R. (Case 1) has returned to his rope works and, though not operating the same high-speed machine, is earning the same wage as before his accident. A. C. (Case 2) has found employment in the boot-making trade. Using his 'forceps hand', he can pick up and place in position the small sprigs used in soling shoes. He drives them with a hammer held in his left hand.

In Case 1 the distal portion of the finger was amputated at the time of operation as it was thought that the finger would be too long and cumbersome (The thumb is normally two phalanges shorter than the index finger). It was later considered that this was a mistake. The value of a nail and so specialized an area as the finger pulp is too great for them to be sacrificed for appearance and stability. Although the base of the first metacarpal, carrying the insertion of the long abductor tendon, was present, it was not necessary for the success of the operation. A fibrous joint between the transplanted metacarpal and the recipient carpus is quite satisfactory, provided the tendon of abductor pollicis longus is drawn down and fixed to the metacarpal. The direction of pull of the flexor tendons creates an adduction force which, if unopposed by an abductor, will draw the finger away from its all-important position of opposition to the middle finger (now the index finger).

It will be recalled that in Case 2 non-union with displacement of the bone ends occurred after the finger had been transplanted, and yet rapid union

followed a subsequent operation at which the bone ends were freshened and resutured. Two possible reasons for this are suggested. First, the blood-supply of the finger following its transplantation must have been very poor, and vascular insufficiency may have been a direct cause of the failure to unite. Secondly, the bone suture at the time of the transplant was performed with catgut, and at the subsequent operation with stainless steel wire. Wire ensures a more adequate and lasting fixation than catgut with less tissue reaction, in no case where I have used stainless steel wire for bone suturing has delayed union or displacement of the fragments occurred.

Case 2 illustrates the extreme importance of maintaining the position of function of the hand throughout all stages of treatment. During the skin-grafting stage the thumb became adducted and the wrist flexed. These deformities were produced by the position of the hand as it lay on the body surface for a period of four weeks. The possibility of such deformities occurring was foreseen from the outset and attempts were made to prevent them by various means, including moulded perspex splints, but the attempts were, for the most part, unsuccessful.

#### WHOLE FINGER GRAFT FROM THE OTHER HAND

Case 3—W. B., aged 15. This lad had his right hand caught in a mincing machine and lost the greater part of all four fingers (Fig 173).



FIG 173—Case 3. Amputation of all four fingers in a mincing machine.

#### OPERATIVE TECHNIQUE—

1 *Initial Operation*—It was decided at this primary operation that a whole finger graft from the other hand should be performed at a later date, and the index stump was chosen as the recipient site. As conservation of the length of this stump meant much to the success of the future transplant, a minimum of bone excision was carried out though this meant suturing the flaps under considerable tension.

2 *The Finger Graft*—The general plan of this stage was as follows: to divide all structures of the ring finger of the left hand with the exception of a soft-tissue flap on the ulnar side, this flap containing the digital artery and nerve, to swing the distal segment of the finger ulnarwards through an angle of 90° and oppos

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its raw end to the prepared end of the right index stump (Fig 174), to suture the bone, the tendons, and the digital nerve on the exposed side, and finally, to cover

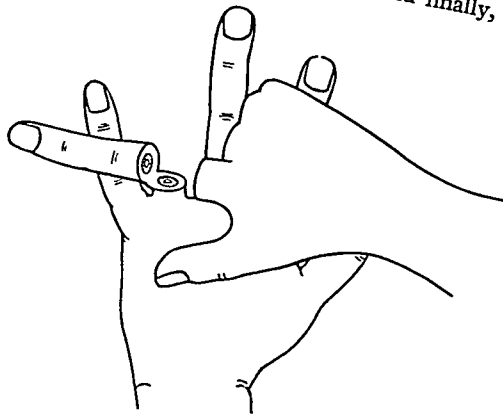


FIG 174—Same case Showing left ring finger swung on a neurovascular pedicle through 90° and ready to be opposed to end of right index stump

raw areas and allow the fingers to grow together. If structures were to be divided and sutured at the same level, there would be a danger of the formation

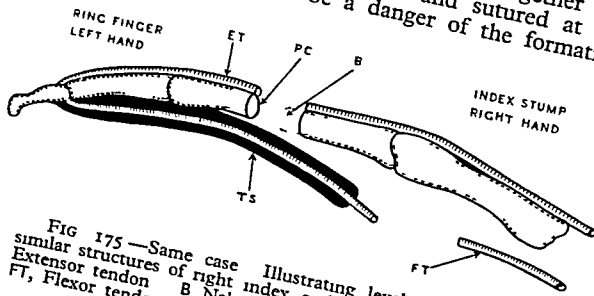


FIG 175—Same case Illustrating level of division of similar structures of right index and left ring fingers. ET, Extensor tendon. B, Naked bone end. TS, Tendon sheath. FT, Flexor tendon. PC, Periosteal cuff.

of a through-and-through block of scar tissue incorporating all suture lines and seriously interfering with both blood-supply and function. To minimize this

danger, each structure was divided at a different level in the following manner —

**Right index finger (Fig 175)** The stump was first cleanly guillotined as near to its distal end as possible, then, working proximally through a lateral incision on its radial side, the periosteum and the extensor expansion were incised round the full circumference 1 cm from the guillotined surface. The portion of the periosteum distal to this incision was elevated and removed, leaving



FIG 176—Same case Photograph taken at operation after suture of bone, periosteum, and tendons

a length of 1 cm of naked bone protruding beyond the periosteal edge. The digital nerves were divided midway between the end of the bone and the end of the periosteum. The adherent and fibrous flexor tendon was dissected free and divided through healthy tendon tissue in the palm above the tendon-sheath.

**Left ring finger (Fig 175)** Here the incision passed round the base of the finger but did not completely encircle it on the ulnar side. Through a lateral incision on the radial side, proximal to the first incision, the periosteum, together with the extensor tendon, was divided 1 cm proximal to the level of the circular skin incision, it was then elevated in the form of a cuff distally for a distance of 1 cm. At this level the bone was sectioned and the periosteal cuff allowed to fall back. The digital nerve on the radial side was, as before, divided midway between the bone and periosteal ends. By careful dissection the fibrous sheath containing the flexor tendons was stripped from the base of the proximal phalanx and the neck of the metacarpal, and the tendons

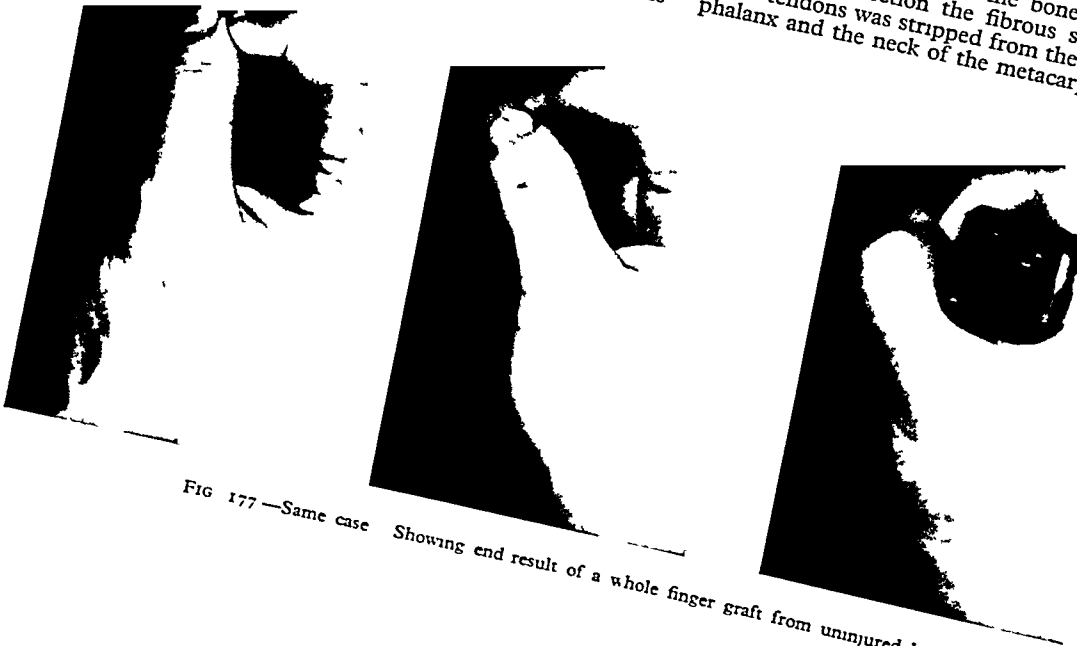
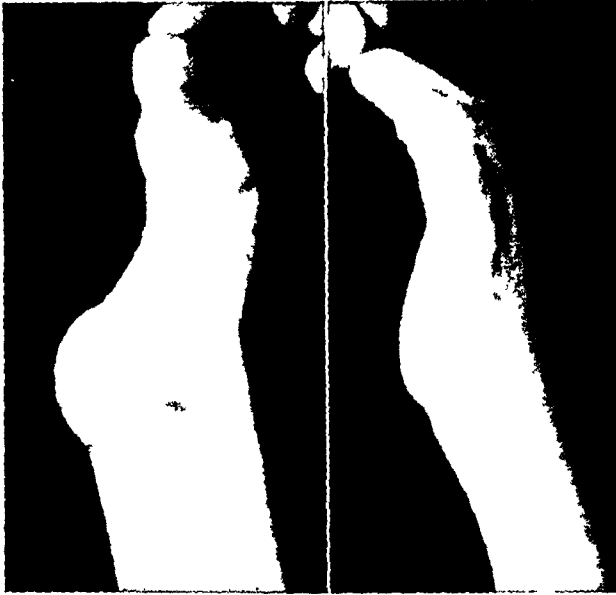


FIG 177—Same case Showing end result of a whole finger graft from uninjured hand

divided in the palm above the proximal end of the sheath. Access to this latter part of the dissection was gained through a separate incision in the palm.

The hands were crossed and the forearms bound into a plaster shell which had been prepared some days

the hand. It will be recalled that these structures are two digits opposed to each other, at least one of them being mobile. Before this aim was achieved, three separate plans of reconstruction were devised and attempted.



FIGS 178, 179—Case 4. Anti personnel bomb injury to right hand. Numerous bomb fragments are seen in the radiograph.

previously. The distal portion of the left ring finger was swung on its neurovascular pedicle through an angle of  $90^\circ$  and its end brought into apposition with the end of the right index stump. The periosteal cuff of the ring finger was slid over the naked bone end of the index stump and all divided structures came together end to end. Stainless steel wire was used throughout in suturing the flexor digitorum profundus tendon, bone, extensor expansion, and digital nerve, in that order (Fig 176). The wound was closed by first suturing the opposed edges of the two circular incisions. This left the proximal edge of the circular incision in the ring finger and the longitudinal incisions on the radial side of each finger to be dealt with. The longitudinal incision in the ring finger was closed completely while that in the index stump was closed in its proximal two-thirds, the distal one-third being left open. By retracting the edges of this terminal portion of the incision, a roughly semi-circular edge was obtained. This edge was sutured to the free edge of the circular incision in the ring finger.

Twenty-three days after the first operation the hands were separated by dividing the soft-tissue flap which connected the two fingers. Suture of the remaining digital nerve and closure of the wound completed the transplant. Fig 177 shows the result eight months after the completion of the second stage.

**Case 4**—W. M., aged 12. This boy, who was kindly referred to me by Mr T. McW. Millar, had most of his right hand blown away by the explosion of an anti-personnel bomb (Figs 178, 179). It will be seen from Fig 179 that the sole remaining bony structures of the hand were the metacarpal and a portion of the proximal phalanx of the middle finger, and the metacarpal of the ring finger. A small range of movement was present at the metacarpophalangeal joint.

This case proved to be extremely difficult and many misfortunes and failures were encountered.

The general aim of reconstruction was the restoration of the structures which subserve the basic function of

#### OPERATIVE TECHNIQUE—

**I. First Plan**—To construct an artificial digit from living tissues, the digit to be fixed to the anterior aspect of the carpus and thus to face the middle finger, to

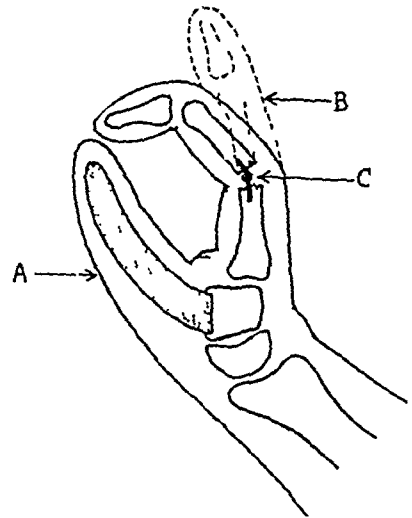


FIG 180—Same case. First plan. A, Fixed unit: skin tube and bone-graft. B, Mobile unit: distal half of the metacarpal and proximal phalanx of middle finger. C, Point of action of mobile unit: the metal hinge.

restore mobility to the middle finger, to create an accommodation space between the two digits, the restoration of mobility and the creation of the accommodation space to be achieved by making a false joint in the shaft of the metacarpal (Fig 180).

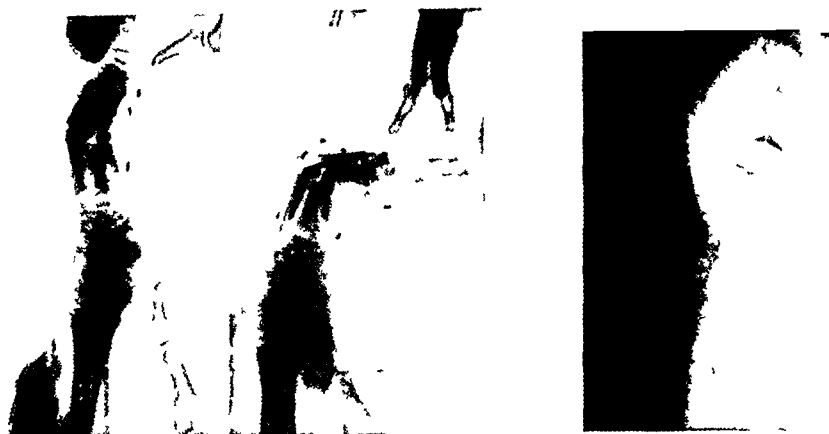
A tubed pedicle graft was raised from the skin of the right iliac fossa. Through a dorsal incision in the

hand, stainless steel hinges were inserted in the metacarpals after dividing them at the centre of the shaft (Fig 181)

New bone grew round the hinges and firm bony union occurred. A semiflexed position, however, was deliberately maintained. Though the arthroplasty had failed, an accommodation space had been gained by what amounted to an osteotomy (Fig 182). Owing to

*Right hand* A palmar incision was made over the carpus. The stump of the median nerve and the tendons of flexor pollicis longus and flexor digitorum sublimis to the index finger were dissected free from scar tissue. A bed was prepared in the carpus for the reception of the left fourth metacarpal.

*Left hand* A palmar incision was made over the fourth metacarpal. The digital nerve and artery to each



FIGS 181, 182—Same case. Three weeks after insertion of hinges, showing passive flexion of almost 90°

the failure to obtain mobility in this digit—the only possible one—the whole plan had to be abandoned.

2 *Second Plan*—To utilize the carpo-metacarpophalangeal unit as the fixed digit and to obtain a mobile digit by a whole finger graft from the uninjured hand (Fig 183). The aim of this plan was to divide at its centre the metacarpal of the ring finger of the uninjured hand, to bring the distal portion together with flexor and extensor tendons and digital nerves through the

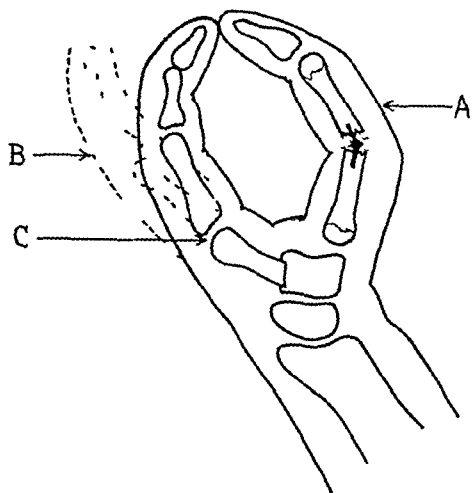


FIG 183—Same case. Second plan. A Fixed unit: metacarpal and proximal phalanx of middle finger. (The stippled area around the hinge indicates bony ankylosis.) B Mobile unit: all three phalanges of the grafted finger. C, Point of action of mobile unit: metacarpophalangeal joint of the grafted finger.

incision into the palm of the hand, then to pass them through an incision on the palmar aspect of the damaged hand, fix the metacarpal to the bones of the carpus, and suture the tendons to the distal ends of similar structures of the injured hand, and finally to complete the union of the two hands by suturing together the corresponding margins of each incision.

side of the ring finger were sectioned, and the flexor tendon divided high up. A dorsal incision was then made, the extensor tendon divided, and the metacarpal divided obliquely at about its midpoint.

*Both hands together* The hands were brought face to face. The distal half of the divided metacarpal was flexed to a right angle at the metacarpophalangeal joint and, with the distal portions of the flexor and extensor tendons and digital nerves, brought out through the palmar incision. They were then passed through the palmar incision of the injured hand. The metacarpal stump was fixed to the recipient carpal bed, the flexor digitorum profundus tendon sutured to flexor pollicis longus, and the extensor tendon to the stump of flexor digitorum sublimis to the index finger. The digital nerves were sutured to the end of the median nerve. To complete this stage, the corresponding margins of the palmar incisions in each hand were sutured together, enclosing the above structures and uniting the two hands. The dorsal incision in the left hand was then closed.

At the end of twenty-eight days, a V-shaped incision was made on the dorsum of the left hand, the open ends of the V being in the interdigital clefts adjacent to the ring finger. The incision was deepened till all structures which were to be left behind were reached. Only these structures and the skin and subcutaneous tissues on the palmar side now remained. At this juncture, the circulation of the finger began to deteriorate and the separation was discontinued. The wound was packed open with gauze and the patient returned to bed.

Fourteen days later, the separation was completed by making a similar V-shaped incision on the palmar aspect of the left hand and deepening it until its two limbs met those of the dorsal V. The abdominal skin-tube was utilized at this stage to cover the raw area on the upper and lateral aspects of the grafted finger.

Unfortunately, mild sepsis occurred after the first operation, with the result that tendon action was lost and bony union failed to occur between the donor metacarpal and the recipient carpus. The bone ends were now exposed, freshened, and re-fixed. A free graft of an extensor tendon of the foot was used to replace a portion of the flexor tendon which was irreparably damaged by fibrosis. Again there was a lighting up of sepsis.

and again tendon action was lost and bony union failed to occur

A review of the situation now showed that the actual transplant of the finger had been achieved, but that it

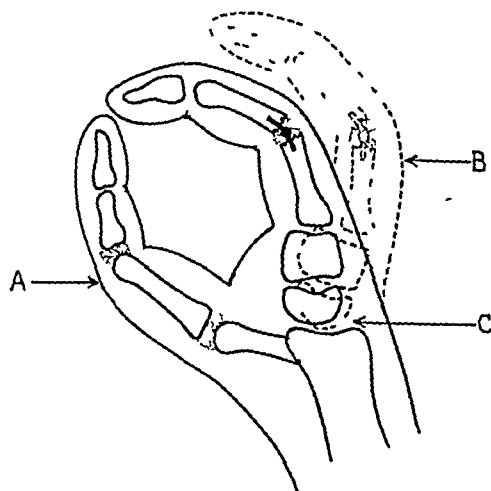


FIG 184—Same case Third plan A, Fixed unit whole of grafted finger B, Mobile unit carpus, metacarpal, and proximal phalanx of middle finger C, Point of action of mobile unit radiocarpal joint (The stippled areas indicate bony ankylosis)

was flail and without active movement. With all hope of obtaining active movement now gone, a further attempt to fix the finger to the carpus would have been futile as both digits fixed to the carpus and without independent motion would move together with the carpus. This plan had therefore to be abandoned.

**3 Third Plan**—To re-graft the finger to the lower end of the radius using it as the fixed digit, the carpo-metacarpo-phalangeal unit acting as the mobile digit (Fig 184).

Through a long antero-lateral incision, the grafted metacarpal and proximal two phalanges were exposed. Both the metacarpophalangeal and proximal interphalangeal joints were excised and a long gutter passing through all three bones on their dorsal aspects was made. A graft was cut from the radius, slid downwards, and locked into the gutter after the whole finger had been moved upwards from the carpus to the distal end of the radius.

At this time penicillin was available and, with its use, sepsis did not occur. Fig 185 shows the result of the third plan.

**Comment**—W B (Case 3) is now employed as a bar tender, and his sole complaint is that he is unable to grasp the larger whisky bottles. All other bottles and glasses he handles with ease.

W M (Case 4) At the present time, only six weeks after removal of the plaster, there is as yet little power in his grasp, though he is able to hold a cylinder of metal one and a half inches in diameter and weighing one and a half pounds. He can hold a thin sheet of paper and a pin in his finger-tips and can write quite legibly. He is employed as a messenger boy for four hours during the day. At night he attends a technical school, where he is taking a course in engineering.

The response to sensory stimuli in the above two cases is very different. Case 3 shows an almost

normal response to both exteroceptive and proprioceptive impulses. Pain, temperature, and touch are appreciated in the whole finger with the exception of a small area on the ulnar side of the terminal phalanx. Discrimination is not always accurate, but localization is good and stereognosis is present. Joint position is very accurately determined, and variations of pressure are appreciated. Sweating of the finger occurs, and no trophic changes are present. In Case 4 appreciation of both superficial and deep sensibility is absent. The finger does not sweat. It is somewhat tapered and the skin is rather shiny, but ulceration has not occurred. In Case 3 tendon and nerve sutures were successfully performed. In Case 4 sepsis occurred after the first two operations, the third operation of re-grafting the finger from the carpus to the radius was performed without regard to tendons or nerves.

In the transfer of a finger from one hand to the other, the interval of time between the first and second stages is of vital importance. The loss of a normal finger from the uninjured hand, if due to the too early severance of its pedicle, would be a disaster. In estimating the time when the blood-supply from the recipient hand to the grafted finger is adequate enough to allow of its separation, the tourniquet test may be relied upon. The method of application of this test as used in Case 4 is as follows. With the patient in the supine position, the arms with their interlocked hands are raised vertically above the head. Both limbs are then emptied of blood by

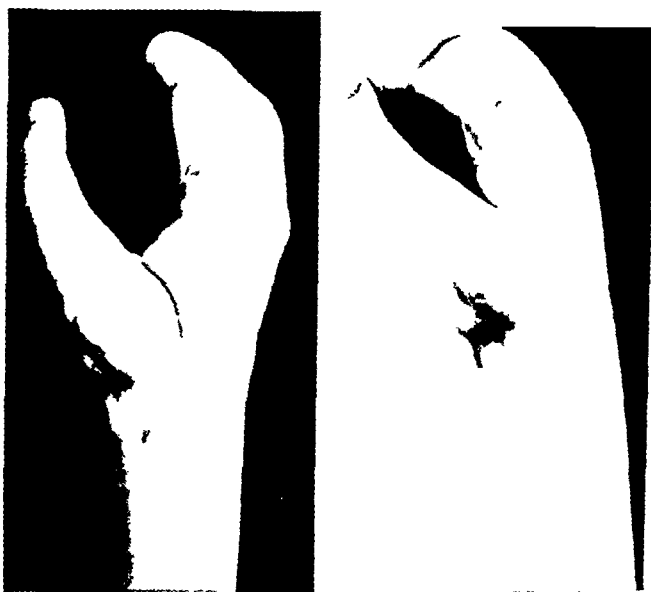


FIG 185—Same case Showing the hand after completion of third plan. Photographs taken immediately after removal of plaster cast.

applying a rubber bandage in an upward direction from the wrist to above the elbow. A second bandage is then applied to each arm as a tourniquet and the first one removed. Both hands are now totally ischaemic and white. The arms are lowered and the tourniquet on the arm of the recipient hand is removed. The flush which follows the tourniquet

removal is watched as it spreads down the limb. If it continues on into the grafted finger, an adequate blood-supply from its host may be assumed and its separation from the donor hand proceeded with.

On general principles, the introduction of foreign material into living tissue should be avoided if possible, particularly in an area where a high degree of function is required, but it is not unreasonable to assume that, with the recent advent of materials which excite very little tissue reaction, in certain cases some form of mechanical hinge could be used as a means of arthroplasty.

A stiff proximal interphalangeal joint is a very crippling disability and presents an extremely difficult therapeutic problem. The results of capsulotomy are very variable and even excision of the joint with the interposition of fat and fascia may fail to give more than a slight improvement in function. In addition, excision often leaves a distorted and unstable finger. In the gross case where the lesser procedure of capsulotomy is unlikely to succeed, a metal hinge arthroplasty perhaps offers the greatest chance of success. In the case quoted above (*Case 4*) it was surprising that bony union occurred when so many of the causes of non-union were present. The bone ends were separated, foreign material was interposed between the fragments and movement at the fracture was constantly taking place. Active movements were encouraged and passive movements through a maximal range, at first  $90^\circ$  (*Figs 181, 182*), were carried out daily. Since this operation, a different type of hinge has been used on a number of occasions in both the metacarpophalangeal and the interphalangeal joints, with very encouraging results. (This hinge has a large central portion which occupies the whole of the space between the bone ends.)

The following case serves to justify the operation of hinge arthroplasty. In this patient two adjacent metacarpophalangeal joints presented an equal degree of stiffness, not more than a few degrees of active flexion being present. Both had failed to respond to a capsulotomy owing to the very gross post-infective fibrosis which was present. Both joints were excised in a similar manner. In one, the bone ends were wrapped in fascia and a pad of fat interposed. Into the other a stainless steel hinge was inserted. Both fingers received the same post-operative care and physiotherapy. Exactly the same degree of active flexion was obtained at each joint—nearly  $60^\circ$ . The joint in which excision alone had been performed had a greater degree of lateral instability than the one into which the hinge had been inserted.

#### MANUFACTURE OF AN ARTIFICIAL DIGIT FROM LIVING TISSUES

*Case 5*—E. C., aged 18. This lad had his right hand crushed in a mechanical hammer. The thumb was lost at the metacarpophalangeal joint, and the middle, ring, and little fingers at the base of the middle phalanges. The index finger, though severely damaged, was saved (*Fig 186*), but could not be used to reconstruct the thumb as in *Case 1*. It was, therefore, proposed to manufacture a thumb from living

tissues. In view of the disadvantages and difficulties associated with a long digit of this nature, it was decided that only a short prop should be used.



FIG 186—*Case 5*. Showing loss of thumb and portion of the ulnar three fingers.

**OPERATIVE TECHNIQUE**—A tube pedicle graft was raised from the skin of the right flank. In this situation the skin closed readily beneath the tube.

After three weeks, the upper end of the tube was freed and applied over the head of the first metacarpal, after the skin had been excised in the form of an ellipse.



FIG 187—Same case. After construction of a short-prop artificial digit from a skin tube and free cancellous bone-graft.

In a further three weeks the separation of the tube from the abdomen was completed, and its free end closed by fashioning two flaps of equal length.

Ten months later, a free graft was taken from the iliac crest and implanted in the tube. A curved incision

parallel with the iliac crest and 1 in. below it was made immediately behind the anterior superior iliac spine. The gluteal muscles were stripped from the crest and turned downwards. A portion of crest was then resected with an osteotome, care being taken to leave the cortical bone of the inner aspect of the ilium untouched, the portion excised consisted of the outer three-quarters of the thickness of the crest. The gluteal muscles were

her and she is very grateful for her new thumb. The addition of an artificial nail would be a very great advantage in this type of case. To facilitate the wearing of such a nail, the preparation of a nail fold by overlapping the end flaps of the tube at the time of its removal from the abdomen is at present under consideration.



FIG 188—Case 6. Showing loss of terminal phalanx of left thumb.



FIGS 189, 190—Same case. Showing result of replacement of a distal phalanx by a skin tube and free cancellous bone graft. The radiograph of the bone-graft nine months after operation is similar in appearance to one taken four months after operation.

then sutured back to the remaining inner portion of the crest. This method of cutting a graft was used to prevent the formation of a hernia which had occurred in an earlier case. The skin tube was opened by a lateral incision and its central core of fibro-fatty tissue excised. The head of the metacarpal was dissected free and a portion of it excised. The free graft was forced into the tube under end-to-end tension, and fixed to the metacarpal by two stainless steel wire sutures passed through drill holes at right angles to each other. Fig 187 shows this boy's hand twelve months after operation.

**Case 6—C. McL.,** aged 15. This girl lost the terminal phalanx of her left thumb in a bacon-slicing machine (Fig 188). An operation similar in all respects to the one described above (Case 5) was performed. Figs 189, 190 show her hand nine months after operation. At the time of the photograph (Fig 190), the thumb was somewhat oedematous, the result of a blow she had received a week previously.

**Comment—**In E. C. (Case 5), though the new finger lacks length, the function is surprisingly good. Before operation he was unable to pick up small objects and his grasp was weak. Now he is able to hold a pin between the finger-tips, and his grip for anything but large objects is very powerful. The sensory response to touch and pin-prick is accurate. Bony union is very sound and the viability of the finger in general is excellent. During the past eighteen months he has been employed as an apprentice engineer in a machine shop.

C. McL. (Case 6) illustrates the use of this method of finger reconstruction from the cosmetic point of view. With the loss of only the distal phalanx of her thumb, function was, of course, little curtailed, but she was very depressed about the appearance of her hand and it was for this reason that the operation was undertaken. Her depression has now left

It has been mentioned that one of the main disadvantages of this method of restoring a lost digit is the lack of mobility. To overcome this disadvantage, the manufacture of a mobile artificial digit from living tissues is, at the moment, under consideration. The general plan of this reconstruction is to insert into the base of the skin tube a free graft of a whole metatarsophalangeal joint from a toe, and when this graft has taken, to insert into the remainder of the tube a cancellous graft using the distal segment of the joint as the new bony host.

### SUMMARY

Three methods of restoring lost digits to a hand are described: (1) The transference of a digit of the same hand, (2) A whole finger transplant from the other hand, (3) The manufacture of an artificial digit from living tissues.

Case histories are given in illustration of each method.

The use of a metal hinge as a means of arthroplasty is suggested.

The possibility of constructing a mobile artificial finger from living tissues and of adding an artificial nail to such a digit is mentioned.

I wish to acknowledge my indebtedness to Professor J. R. Learmonth for his encouragement in this type of work and for his helpful criticism and suggestions in the preparation of this paper, to Mr. David Band and other members of the Honorary Staff of Leith Hospital for their co-operation and assistance in establishing a hand unit, to Mrs. Selby Tulloch for the line drawings, and to the nursing staff of Leith Hospital for their patient and careful attention to the many details which these cases involve.

# MYELOGRAPHY IN LUMBAR INTERVERTEBRAL DISK LESIONS

## A CORRELATION WITH OPERATIVE FINDINGS

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THE value of myelography in the investigation of patients thought to be suffering from intraspinal protrusion of the lower lumbar intervertebral disks is still a matter of controversy. At first, when this new field of surgery was being explored, an abnormal myelogram was considered essential for diagnosis (Mixer and Barr, 1934, Hampton and Robinson, 1936, Love and Camp, 1937), but with increasing experience it was found that the diagnosis could be made readily from clinical features alone, and, indeed, even more accurately, for some disk prolapses could not be demonstrated by myelography (Semmes, 1939, Bradford and Spurling, 1941, McKenzie and Botterell, 1942). It was also learnt that the myelographic appearances might be difficult to interpret, and could be confusing or misleading, and this prompted some authorities to discredit the procedure (Dandy, 1941 and 1943, Skidders and Hamby, 1944). More recently, however, other investigators employing pantopaque as the contrast medium have claimed that they can demonstrate lumbar disk protrusions with complete accuracy (Childe, 1945, Soule, Gross, and Irving, 1945), while yet others using the same medium have found that the myelogram may be normal, and yet a disk protrusion be present (Eaglesham, 1944, Arbuckle, Shelden, and Pudenz, 1945).

This controversy appears to be the result of an incomplete appreciation of the uses and limitations of myelography in intervertebral disk protrusions. We have therefore analysed our experiences in 100 consecutive cases of lumbar disk lesions submitted to operation. In this series the diagnosis was based on history and physical signs alone (Falconer, 1944). None the less, myelography was employed as a routine, for we found that this procedure is valuable in revealing not only the level of a disk protrusion, but also its site in relation to the theca and extrathecal nerve-roots. Thus the myelogram shows whether a protrusion is centrally placed or laterally placed—information which is helpful, for at operation it has often proved necessary to deal with a centrally placed prolapse from both sides of the theca, rather than by a unilateral approach. Further, multiple disk protrusions are not infrequently present, a fact which it is also useful to know before operation. Finally, myelography may disclose cauda equina tumours and other lesions which simulate an intervertebral disk syndrome.

Thus myelography tells the surgeon beforehand what to expect at operation. As a surgeon forewarned is a surgeon forearmed, a consideration of our experiences may assist others.

### NOMENCLATURE

In the literature a number of terms have been used to describe intraspinal protrusions of intervertebral disk tissue. Among the terms which have

become almost synonymous through usage are prolapse, protrusion, rupture, and herniation. Because of this confusion of terminology, it seems desirable to define at the outset the terms which we have found useful in describing different types of lesion. In common with others we employ 'prolapse' and 'protrusion' as synonymous generic terms covering all types of these intraspinal lesions. From our operative and myelographic experience, however, we feel that these lesions may be subdivided with advantage into four separate groups, as follows—

1 *Projections*—The commonest type is a constant, localized projection of nuclear substance still covered by the smooth, glistening, annulus fibrosus, thinned but intact.

2 *Intermittent Prolapses*—Next in frequency is an intermittent prolapse which may protrude only when the intervertebral disk is subjected to certain strains. This type is probably similar to the 'concealed' disk described by Dandy (1941).

3 *Extrusions*—In some cases the annulus fibrosus ruptures, allowing nuclear material to escape free into the spinal canal. This we term an 'extrusion'.

4 *Scarred Disks*—Over a period of years the opposing surfaces of the vertebral bodies may become sclerotic, the disk space may become greatly diminished in width, and at operation the theca and extrathecal nerve-root may be found firmly adherent to the back of the disk without an actual projection being present. This we call a 'scarred disk'.

### CASE MATERIAL

Myelography, employing either 'Pantopaque' or 'Lipiodol Lafay' as the contrast medium, was carried out in 95 of 100 consecutive cases of sciatica and low back pain occurring singly or in combination, while in 1 case an oxygen myelogram was used. The clinical features, operative findings, and results of treatment of this group will form the subject of another study. With one exception disk lesions were found at operation in all cases. Some patients were explored more than once because the pathological disk tissue had been inadequately removed at the first operation. Eventually all cases of sciatica were benefited, as were the majority of cases of severe low back pain unaccompanied by sciatica. During the investigation we encountered one case of tumour causing sciatica. This was an extrathecal hydatid cyst which was distinguishable by myelography. It would seem from our experience that intervertebral disk lesions are the only common cause both of sciatica and of severe low back pain.

Early in the series we encountered 9 cases in which the myelograms were worthless because of artefacts arising from faulty technique. By experience we learnt the causes and the significance of these artefacts, and later how to obviate them. The principal analysis is based on the 86 cases in which myelograms



were satisfactory. In 42 of these pantopaque was the contrast medium, and in the remainder (44) lipiodol. Pantopaque was employed for preference, but as supplies were not always available, lipiodol had at times to be used instead. Myelography was not carried out in 4 cases because no suitable medium was available at the time.

### METHOD OF EXAMINATION

Our method of examination resembles that employed by most authorities, but it differs in certain respects. We inject 3 c.c. of contrast medium through a lumbar-puncture needle inserted at the third or fourth lumbar interspace with the patient lying on his side. The needle is then withdrawn. The examination is carried out as soon as convenient, the patient meanwhile remaining recumbent.

The examination is begun with the tilting table vertical, and the patient standing on the footplate facing it. Thus, at the outset, the contrast medium is collected in a mass in the thecal cul-de-sac. Then, as the head of the table is lowered, it flows evenly up the lumbar canal, its progress being watched carefully on the fluorescent screen. Most patients need not move during the whole examination, but occasionally it may be necessary to rotate a patient into an oblique position to obtain better filling of the root pouches, or to investigate further a suspicious filling defect. As the medium straddles each disk space, anteroposterior films are exposed with the spot film device, while the angle of tilt of the table is noted. Once all the lumbar interspaces have been inspected, tilting of the table is reversed, and the opaque medium observed as it flows slowly back to the bottom of the lumbar sac. The constancy of an abnormality may thus be established, and, if necessary, the whole manoeuvre may be repeated. Prone-lateral views of the lower two lumbar interspaces are taken as a routine, and this is facilitated by placing the tilting table at the angles previously noted. An independent rotating-anode tube and a wafer grid are used. We have found these lateral views most helpful in the subsequent interpretation, although many authorities have apparently found them of little use (Hampton and Robinson, 1936, Childe, 1945, Soule, Gross, and Irving, 1945). Oblique views, on the other hand, rarely reveal information which cannot be derived from a study of the anteroposterior and lateral projections.

Recently we have introduced a manoeuvre which we believe increases the scope of the examination, especially in cases where the myelograms at first sight seem normal. While the opaque medium lies in relation to each disk space, hyperextension of the spine is effected by asking the patient to raise his head and shoulders as far off the table as possible, without altering the position of the lower portion of the trunk. In this way we have been able to demonstrate lesions which the usual technique had failed to disclose. These lesions are of the type which we describe as 'intermittent prolapses'.

In only a few cases was the contrast medium subsequently removed by aspiration through a lumbar-puncture needle as recommended by Kubik and Hampton (1941). Lipiodol we generally aspirated at operation after the theca had been opened.

Pantopaque, however, was often left in situ, and no harmful effects have been noticed. This has enabled us to screen our patients at intervals after the initial myelogram. Filling of the root pouches may not be complete for some days, and so delayed myelography has occasionally demonstrated abnormalities which were not visible at the first examination. Important information regarding the persistence of defects has also been obtained in patients whose symptoms had disappeared spontaneously. Follow-up radiological studies have confirmed that pantopaque is slowly absorbed, at a rate approximately two-thirds of its volume in a year.

### RELEVANT ANATOMICAL CONSIDERATIONS

The myelographic appearances depend upon the shape of the subarachnoid space, and the extent to which it is filled by the contrast medium. They are also influenced by structures within the subarachnoid space or in proximity to it. Consequently a consideration of the relevant anatomical relationships is important, particularly as in the literature some terms are employed confusingly.

By the term *theca* we refer to the meningeal tube composed of dura and arachnoid which surrounds the spinal cord and cauda equina. This tube presents a number of prolongations or sheaths which

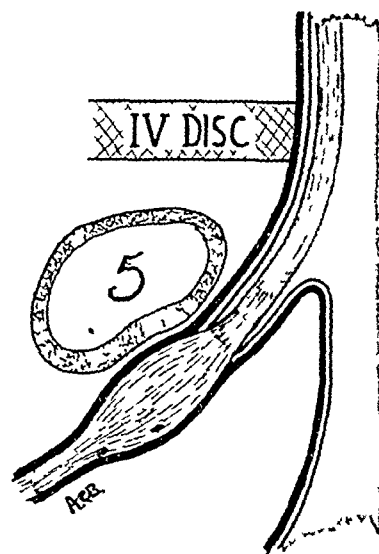


FIG. 191.—Diagram of a root pouch illustrating relationship of dural and arachnoidal sheaths to a nerve-root in its extrathecal course. The subarachnoid space is coloured pink, the arachnoid is depicted by a thin line, the dura by a thick line, the intervertebral disc by cross hatching, and the pedicle by the number of its vertebra.

surround emerging nerve-roots in the first part of their extrathecal course. Each sheath is composed of two layers: the outer, formed by dura, passes on to become the neurilemma of the spinal nerve; the inner, derived from the arachnoid, forms a sleeve which invests the nerve-root for a variable distance, and may reach as far as the dorsal root ganglion before it fuses with the root pia. Hence a prolongation of the subarachnoid space accompanies each nerve-root, and this prolongation constitutes

the *root pouch* (Fig 191) The root pouches of the first and second sacral nerves are the longest

The elements of the cauda equina lie loosely within the subarachnoid space, where they are freely movable Each nerve-root consists of a dorsal and

The arrangements of the individual nerve-roots composing the cauda equina usually conform to one of two main patterns, but intermediate variations occur These patterns may influence the myelographic appearances within the theca (*see Fig 193*)

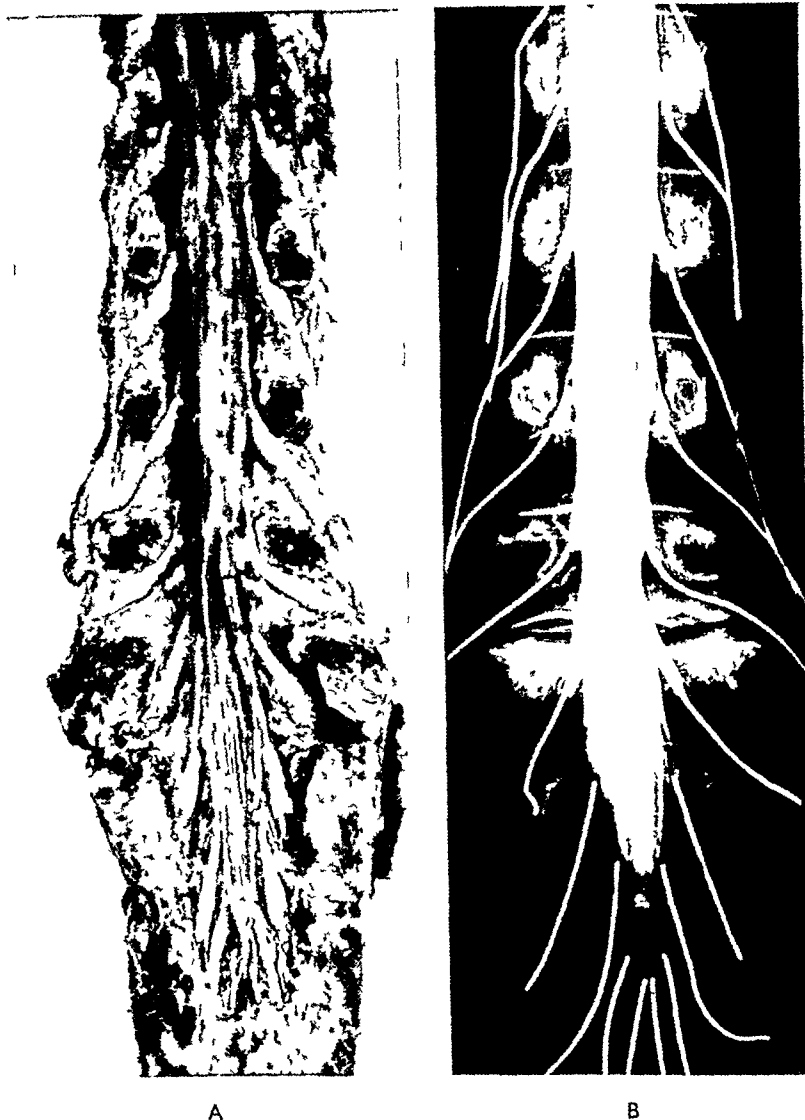


FIG 192—A, Dissection of the lumbosacral region from behind The pedicles had been sawn through, the laminae removed, and the thecal sac and extrathecal nerve roots displayed The nerve-roots in their extrathecal course have been painted white B, Radio-graph of this dissection after lipiodol had been introduced into the subarachnoid space and wires placed in positions corresponding with the extrathecal course of the nerve roots The radio-graph shows clearly the relation of the nerve-roots to the root pouches, and also to the intervertebral discs ( $\times \frac{1}{2}$ )

a ventral component in close apposition As it proceeds towards its point of emergence from the theca, it passes laterally and forwards to lie in contact with the antero-lateral wall of the theca for some distance On entering the root pouch it becomes relatively fixed, and therefore from this point onwards it is more readily affected by external pressure From the theca it proceeds downwards, outwards, and slightly forwards, around the infero-medial aspect of the vertebral pedicle to the intervertebral foramen where its spinal (dorsal root) ganglion is situated

In one pattern the individual nerve-roots are separated from each other, and are so spaced that those about to pass through the theca lie laterally, with the others lying in order on their medial aspect The filum terminale lies between the lowest nerve-roots of either side In the other pattern the nerve-roots are arranged in two large bundles, one on either side of the midline, with a wide free space between Within each bundle the nerve-roots are loosely adherent to one another, and are so placed that each lies posterior or postero-medial to its next cephalic neighbour The filum terminale may lie by itself

in the interval between the two bundles, or it may be attached to the medial margin of one or other bundle.

The anterior wall of the theca is closely applied to the posterior surfaces of the intervertebral disks, being separated from them only by the posterior longitudinal ligament. If, however, the lumbosacral angle is more acute than usual, the theca may be separated a few millimetres by fatty tissue from the fifth lumbar disk. This explains why disk protrusions at the fourth and higher lumbar spaces affect the myelograms more readily than do protrusions at the fifth space. The first sacral nerve-roots emerge from the theca at or just above the level of the fifth lumbar disk. The fifth lumbar nerve roots emerge at or just below the fourth lumbar disk, while nerve-roots higher up all emerge below the disk cephalic to their numerically corresponding vertebra (Figs 192, 197). Consequently disk protrusions situated posterolaterally at the fourth and fifth lumbar space, readily compress the fifth lumbar and first sacral nerves respectively, while similar protrusions at higher levels usually do not involve an extrathecal nerve-root.

A difficulty in the enumeration of lumbar disk spaces arises when there are more or fewer than five lumbar vertebrae. We have found then that the distribution of nerve-roots in relation to the lowest or lumbosacral disk usually indicates that it corresponds to the fifth lumbar disk of persons with five lumbar vertebrae. In this series, therefore, we have numbered the lowest lumbar disk space as the fifth, irrespective of the number of lumbar vertebrae present.

### THE HYDRODYNAMICS OF MYELOGRAPHY

The principle underlying myelography is to introduce into the spinal subarachnoid space some innocuous medium which will outline it when examined by X rays. There are, however, certain points about the hydrodynamics of myelography which, though simple, are not widely appreciated, and which must be understood if myelograms are to be interpreted properly.

The two contrast media, pantopaque and lipiodol, are both iodized oils heavier than cerebrospinal fluid and not miscible with it. Consequently, when introduced into the theca in limited amounts, each substance gravitates to the most dependent portion of the subarachnoid space, where it forms a pool with a horizontal upper surface, above which is cerebrospinal fluid. The shape, depth, and location of this pool alters with the position of the patient. If he stands erect, the pool collects in the sacral cul-de-sac, where its cross-section is limited by the circumference of the theca, and consequently its depth is relatively great. But if the patient lies horizontal in the prone position, the medium will flow towards and cover the anterior wall of the lumbar theca, for that is now the most dependent portion of the subarachnoid space. There it will again form a pool with cerebrospinal fluid intervening between its upper surface and the dorsal wall of the theca. This time, however, the longitudinal expanse of the pool is great, because the lumbar theca is now also horizontal, while its depth is shallow in roughly inverse proportion to its length.

If sufficiently large quantities are introduced, the medium will fill the whole cross-section of the lumbar theca, even when the patient lies horizontally. But we believe there are disadvantages in this, and that 3 c.c. is the optimum amount of any oily contrast medium which should be introduced. This amount when collected along the anterior wall of the lumbar theca forms a pool which is usually sufficient to straddle one disk space at a time, but not two. The pool is relatively shallow, and consequently small projections will

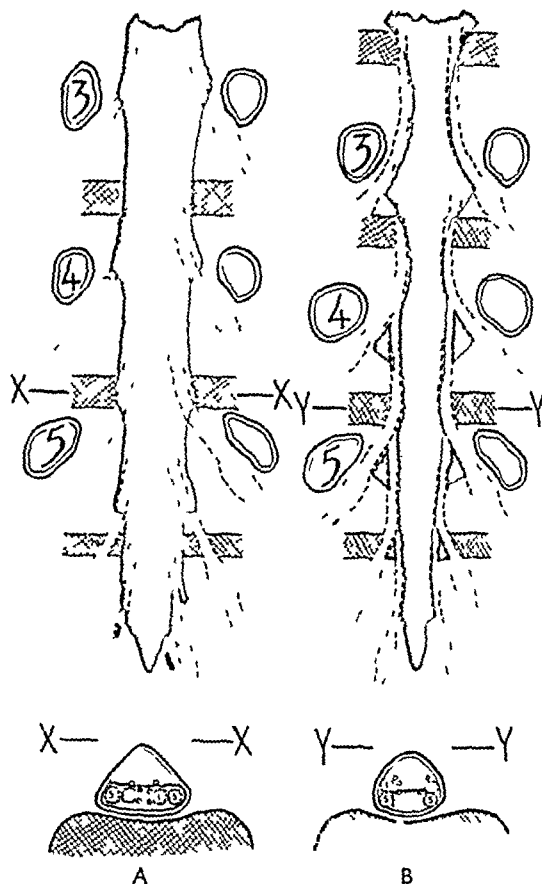


FIG 193—Composite tracing of an actual myelogram depicting A, The cylindrical type, and B, The ringed type of thecal column. Below each tracing is a schematic cross-section of theca at level of 4th lumbar disk, showing nerve-roots with contrast medium in relation to them. Note the two different patterns of the cauda equina.

show through it. If less than 3 c.c. is employed, there may be insufficient medium to outline adequately that portion of the theca which is in relation to the intervertebral disk, especially where the theca is broad. If more than 3 c.c. is used, the pool may be so deep that small projections cannot be seen through it, as its fluoroscopic shadow is too dense. Furthermore, these larger amounts may cover the fifth disk even when the patient stands erect, thus preventing a complete examination of this space.

One disadvantage of both these oily contrast media is their tendency to break up into globules. Lipiodol is a greater offender in this respect than is pantopaque. If on lumbar puncture these substances are injected slowly and steadily, they will usually

collect into one uniform mass. Thereafter care should be taken that the patient is tilted slowly so that the medium flows in one mass, otherwise portions will break off and separate into globules. Once fragmentation has occurred, it may be impossible to fuse the contrast medium together again.

### THE NORMAL MYELOGRAM

It is convenient to consider the silhouette of a normal myelogram under two headings, the thecal column and the root pouches.

**Thecal Column**—A striking and constant feature of the normal thecal column as seen in the anteroposterior view is its symmetry. Variations occur in its shape, width, and length. There are two main types of column, a cylindrical column of even tubular form, and much less commonly a ringed column with zones of constriction between the levels at which successive pairs of nerve-roots emerge. All intermediate grades are seen between the extremes depicted in Fig 193. When the pool of contrast medium is deep, the thecal shadow is of uniform density. When, however, the pool is shallow, the nerve-roots show through as bands of

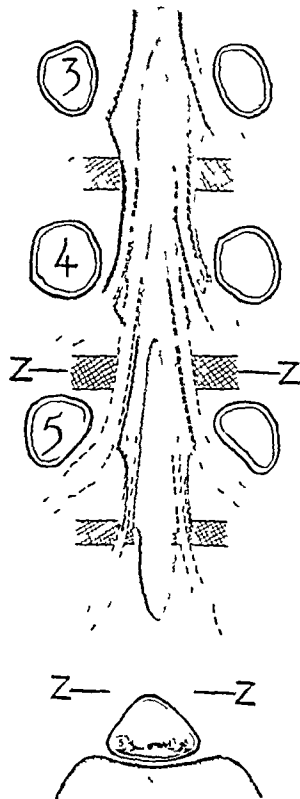


FIG 194—Composite tracing of actual myelogram indicating the topographical arrangement of the cauda equina

radiolucence, particularly if they lie in close apposition to the anterior wall of the theca. This latter appearance is likely to occur in patients with a wide theca and a relatively straight lumbar spine. It may even be possible to appreciate the arrangement of the cauda equina (Fig 194).

The width of the thecal column may vary from 30 to 80 per cent of the interpedicular distance (Fig 195), while its depth, too, may vary. These variations are not directly related to the sex or build of the patient, for we have seen narrow columns in

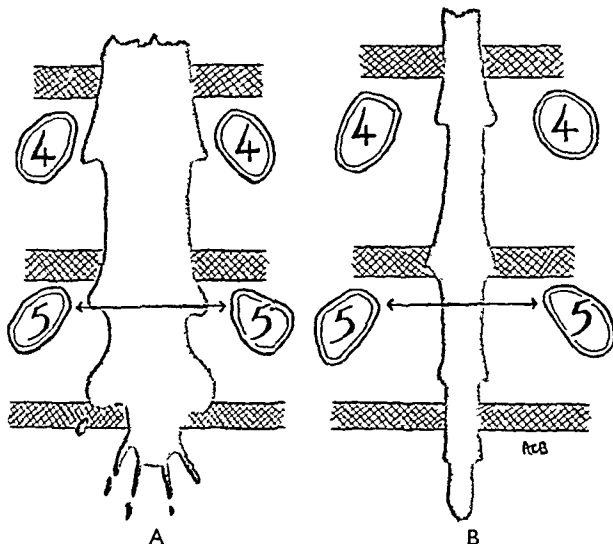


FIG 195—Tracings of myelograms showing A, Broad type, and B, Narrow type of thecal columns

heavily built men, and broad columns in young, slender women.

Generally the thecal column extends as far down as the second piece of the sacrum, but occasionally it may terminate as high as the inferior margin of the fifth lumbar vertebra. When this occurs the root pouches of the sacral nerves are often large and fill well, and consequently the effects of a protrusion of the lumbosacral disk may still be appreciated (Fig 196).

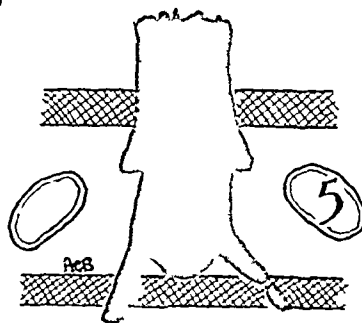


FIG 196—Tracing of myelogram, showing high termination of thecal sac

Prone-lateral views show that, posterior to each intervertebral disk, the anterior wall of the theca is normally indented by the disk and its ligamentous coverings to a depth of up to 2 mm. These small indentations are of no pathological significance, but they may cause an exaggerated and misleading deformity in the upper lumbar region where the spine is straight and the pool of contrast medium consequently shallow. On the other hand, at the fifth space where the theca may not be in contact with the intervertebral disk, an anterior indentation is often absent.

**2 Root Pouches**—The outlines of the root pouches also are usually symmetrical, but the degree to which they fill varies considerably (*Fig 197*). Certain factors affect the filling, of which time, gravity, and the posture of the patient are the most

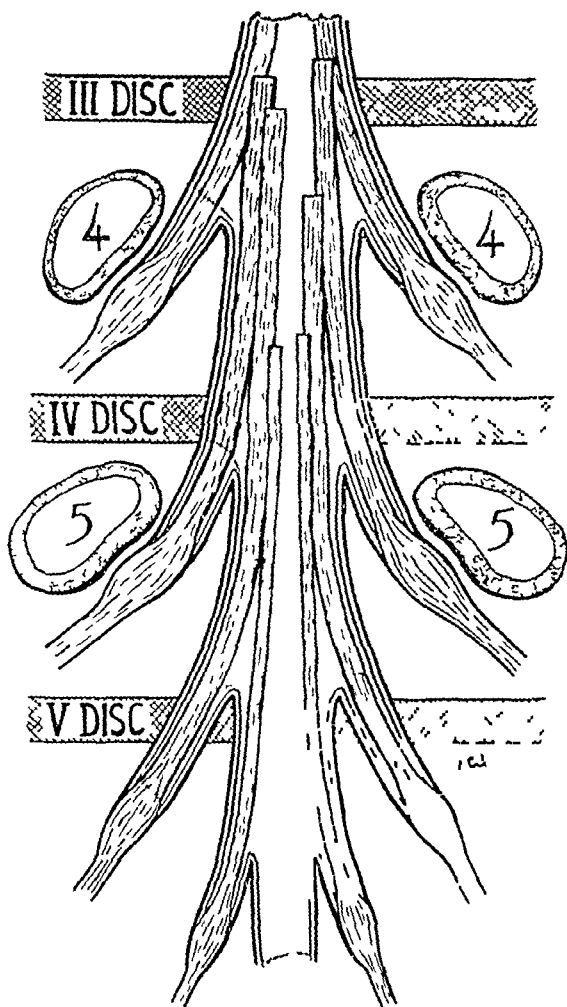


FIG 197—Diagram of a normal myelogram in the lumbosacral region, showing the variations which may occur in the filling of the root pouches with contrast medium, represented by pink wash

important. Thus, if the radiological examination is made immediately after the injection of contrast medium only the orifices of the root pouches may be demonstrated, but if the examination is repeated some days later the sacral root pouches are usually filled in their entirety. The lumbar root pouches, however, do not fill as completely as the sacral pouches, because the contrast medium does not remain in relation to them when the patient sits, stands, or lies.

When filled completely, each root pouch shows as a uniformly dense shadow 3 to 4 mm wide passing downwards and outwards from the main thecal column. If the layer of contrast medium between the nerve-root and the arachnoid is thin, the root pouch may show in the myelogram as two linear streaks with a clear zone between, representing the nerve-root. More frequently, where filling is

irregular, the opaque medium may appear as a single streak lying medial or lateral to the nerve-root. The first and second sacral pouches are the longest and may measure as much as 3 cm in length, while the root pouches higher up are progressively shorter. Often, however, the root pouches do not fill with contrast medium, in which case their orifices are indicated by small projections along the lateral edge of the thecal column (*Fig 197*).

### THE PATHOLOGICAL MYELOGRAM

Prolapse of a lumbar disk usually affects the thecal column or a root pouch. Occasionally, the myelogram may be normal. We have been able to correlate the myelographic appearances with the findings at operation, both as regards the level and the size of the prolapse, as well as the type of lesion.

#### A LEVEL AND SITE OF PROLAPSE

Usually the myelographic abnormalities are situated opposite a disk space, thus indicating the level of the lesion. The site of the prolapse in relation to the theca and extrathecal nerve-roots may also be determined with accuracy. Disk prolapses may be divided into two groups, central and lateral, according to their location in the coronal plane. Central prolapses lie anterior to the theca, while lateral protrusions lie between them and the intervertebral foramen (*Fig 198*). Lesions in either of these situations have their own characteristic appearances on myelography.

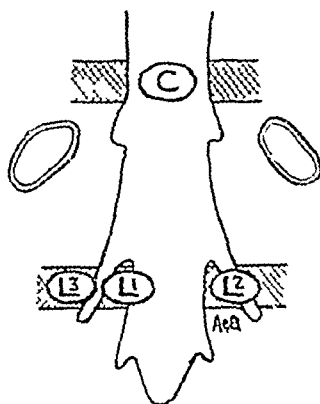


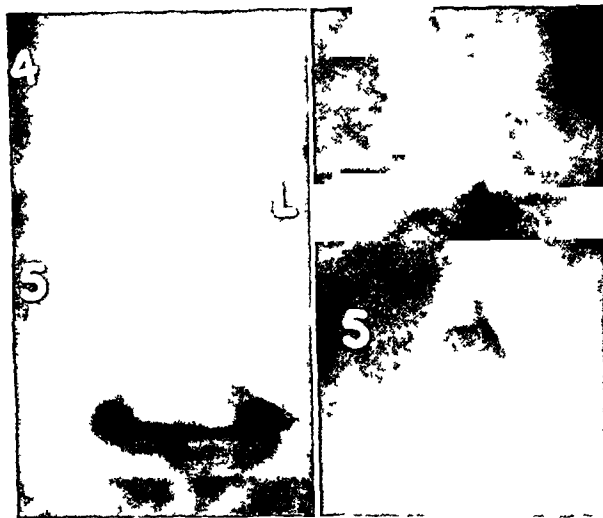
FIG 198—Diagram illustrating sites of central and lateral prolapses

**1. Central Prolapses**—The appearance caused by a central prolapse depends mainly upon the size of the prolapse, but it is also influenced by the arrangement of the cauda equina, and by the variations in distance occurring between the theca and the intervertebral disks at different levels of the spine. If the prolapse is large enough, a complete block will result accompanied by Froin's syndrome (*Fig 199*). It is, however, exceptional for a block to remain permanent and absolute, for if the examination is repeated a few hours later some of the contrast medium will be found to have passed the obstruction, although during screening it could not be persuaded to do so.

Complete blocks are uncommon, for they occur only with the largest prolapses. With medium

sized prolapses the usual finding is an hour-glass constriction of the thecal column, the width of the isthmus varying considerably, as is shown in *Fig 200, A, B*. In the past this 'hour-glass' appearance has been ascribed either to hypertrophy of the

over the prolapse, they hug closely the antero-lateral wall of the theca, leaving a gutter of varying width between them, through which the contrast medium flows (*Fig 201*). Prone-lateral views of these 'hour-glass' constrictions have invariably disclosed an anterior invagination of the thecal column (*Fig 200, C*) and operative exploration has later confirmed it. The 'gap' appearance shown



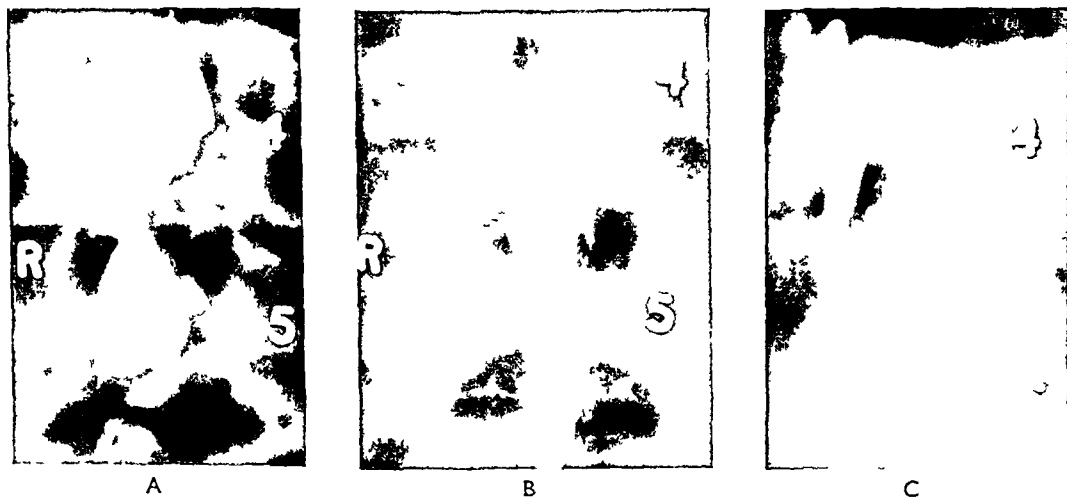
**FIG 199**—Large central prolapse of L4 disk causing complete block, with contrast medium trapped caudal to it. Films taken with table tilted head down 60° below horizontal. **A**, Anteroposterior view showing serrations at edge of block due to nerve impressions. **B**, Lateral view, showing that cephalic end of column is displaced backwards by the prolapse (× 1).



**FIG 201**—Diagrams showing how the 'hour-glass' appearance is produced. **A**, Cross-section opposite vertebral body shows undisturbed position of nerve-roots within contrast medium (pink wash). **B**, Cross-section at level of disk, showing contrast medium lying over summit of midline protrusion in gutter between bundles of nerve-roots.

in *Fig 202* is only an early stage in the filling of the gutter, although it has been described by some authorities as a separate type (Soule, Gross, and Irving, 1945). On screening, the contrast medium, once it has reached the prolapse, can be seen to bank up and spill over it, and then lie on either side of it. When with further tilting of the table the pool deepens, an hour-glass appearance becomes evident.

A less common appearance with a medium-sized prolapse is a rounded zone of radiolucence lying



**FIG 200**—Two examples of hour glass constriction of the thecal column showing variations in width of the isthmus. **A** Shows a narrow gutter. **B** Shows a wider gutter. Note the outlines of nerve roots as they hug the anterolateral wall where stretched over the dome of the prolapse. **C** Prone lateral view of lesion depicted in **A**, showing the anterior invagination of the thecal column (× 1).

ligamentum flavum (Hampton and Robinson, 1936, Camp, 1939) or to a bilateral or dumb-bell-shaped prolapse (Soule, Gross, and Irving, 1945). We cannot however, confirm either of these explanations, for in our experience it is due to a smooth, dome-like protrusion, which invaginates the anterior wall of the theca in the midline and displaces the components of the cauda equina into two bundles, one on either side. Where the two bundles pass

within the thecal column and causing no deformity of its margins as seen in the anteroposterior view. This appearance, the 'veil' effect of Soule, Gross, and Irving (1945), results when the components of the cauda equina lie discretely over the summit of the ridge, instead of in two large bundles. On screening, the advancing column can be seen to split and flow round either side of the projection, although later, as the pool deepens, the projection becomes

submerged and finally obscured (*Fig 203*) Copleman (1944) has made similar observations

In smaller-sized protrusions, and even in some of the larger protrusions at the fifth lumbar space,

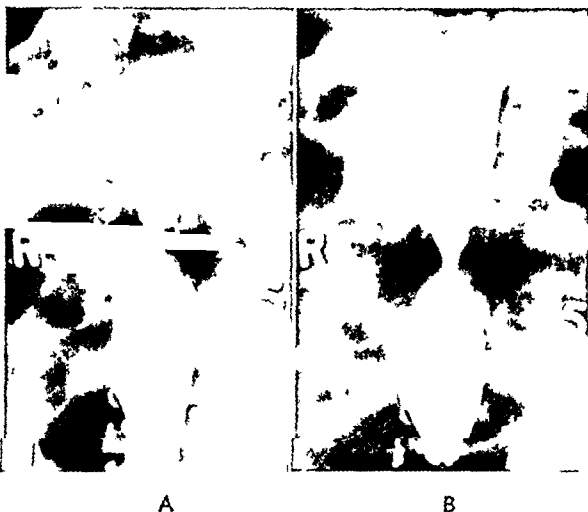


FIG 202—Illustrates two successive stages in the passage of contrast medium over a central prolapse. A, There is an apparent gap in the column, while in (B), the medium is seen flowing through the gutter over the summit of the prolapse ( $\times 1$ )



FIG 203—An example of veil appearance due to a centrally-placed prolapse. A, The advancing column diverges on either side of the prolapse. B, The prolapse is revealed by a central area of radiolucence ( $\times 1$ )

the anteroposterior views may appear normal, and the anterior invagination of the theca be detected only in the prone-lateral projection. This is another reason why we feel that prone-lateral views should be taken as a routine. Normally, there is a slight indentation of the theca opposite each disk space, but these indentations are only of pathological significance when they exceed about 2 mm. Another source of difficulty arises with centrally placed prolapses at the fifth lumbar disk, where, because the theca may here be separated from the intervertebral disk, a prolapse of given size may produce less indentation than a comparable prolapse at a higher level. This explains why the 'hour-glass'

appearance is seen much more often at the fourth lumbar space than at the fifth. The size of all midline protrusions is best assessed in the prone-lateral view.

**2 Lateral Prolapses**—When a prolapse occurs in relation to an extrathecal nerve-root, the myelographic appearance varies according to the distance the prolapse is situated from the mid-sagittal plane. Lesions situated anteromedially to the extrathecal

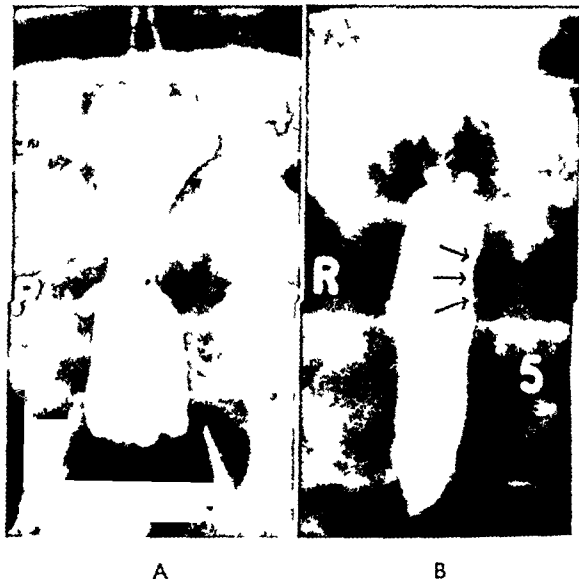


FIG 204—Two examples of lateral prolapse indicated by a defect in the thecal column. A, The defect is large, indicating a large prolapse. B, The defect is small, but this does not necessarily mean the prolapse is small ( $\times 1$ )

nerve-root (see *Fig 198—L 1*) give rise to a defect in the lateral border of the thecal column, while the corresponding root pouch usually fails to fill (*Fig*



FIG 205—Lateral prolapse indicated by absence of filling of S1 root pouch opposite 5th disk on left side ( $\times 1$ )

204). The size of this defect varies and does not indicate accurately the size of the prolapse, as only its medial margin is outlined. A prone-lateral view sometimes reveals the size of the prolapse by a

double shadow. If the prolapse is small it is best seen as the advancing column reaches the disk space or as the receding column leaves it, since it may be completely obscured by the main mass of the opaque column.

Lesions situated anterior or slightly anterolateral to the nerve-root (see Fig 198—L 2) cause a

with a well-marked prolapse, some of these latter prove to be examples of foraminal projections at the fifth lumbar disk remote from the theca and root pouches, but not always.

Observations such as these have in the past brought discredit upon myelography. It has seldom been realized that the projection of a prolapse may



FIG 206—Large prolapse situated far laterally at 5th lumbar space on right side, producing displacement of thecal column by its pressure on 1st sacral nerve root ( $\times 4$ )



FIG 207—Normal myelogram of a patient in whom a lateral projection was found at operation at the 5th space on the left side ( $\times 7$ )

defect in the filling of the root pouch without disturbing the thecal column (Fig 205). We have found that the deformity may be due either to direct pressure of the prolapse on the root pouch or to swelling of the nerve-roots within the pouch proximal to the site of compression.

When the prolapse is situated farther laterally (Fig 198—L 3) the myelogram may show a characteristic change or it may remain normal. If the lesion is a large one its presence may be shown by displacement of the nerve-root, and indirectly of the whole thecal column, towards the contralateral side (Fig 206). If the myelogram remains normal in the presence of strongly suggestive clinical features, we have found that a prolapse is likely to be situated in the foraminal region at the fifth space (Fig 207).

## B TYPES OF PROLAPSE

As mentioned earlier, we have subdivided our cases of prolapse into four groups, projections, intermittent protrusions, extrusions, and scarred disks. This classification is based on operative appearances, which by means of myelography can sometimes be forecast.

**1 Projections**—The appearances which have so far been described are those caused by projections.

**2 Intermittent Prolapses**—All who have had wide experience of myelography know that, although the silhouette of a disk prolapse may have been demonstrated radiologically, the surgeon sometimes will be unable to see a projection when he examines the disk at operation. Less frequently the converse occurs, and the surgeon operating despite a normal myelogram confronts the radiologist

very markedly according to the stresses which are being imposed on the affected disk. Dandy (1941), for instance, stressed that at operation the affected disk may scarcely bulge, and when palpated with

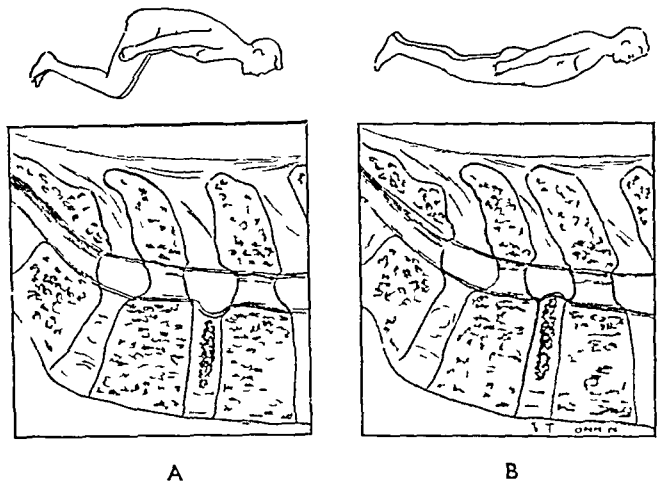


FIG 208—Diagrams showing effect of hyperextension maneuver as performed at operation. A There is no projection backwards of the weakened disk, which is relaxed. B With hyperextension the disk protrudes backwards.

the points of forceps it may indent and give a sense of fluctuation. Disk prolapses of this type he referred to as 'concealed' disks, and he assumed that, as the degree of projection of these disks seemed so slight, they would not be disclosed by myelography.

Few radiologists and surgeons appear to have realized that there is a great difference in the stresses and strains affecting the lumbar disks of a patient on





FIG. 209—Myelograms showing large intermittent central prolapse at lumbosacral space revealed by 'hyperextension' manoeuvre. A, B, Routine myelogram with patient relaxed shows no abnormality in anteroposterior or prone lateral views. C, D, Myelogram during 'hyperextension' manoeuvre demonstrates the presence of a prolapse anteriorly as well as the impression of a relaxed ligamentum flavum posteriorly. The postero-inferior outline of the 5th lumbar vertebra is marked by a dotted line (—).

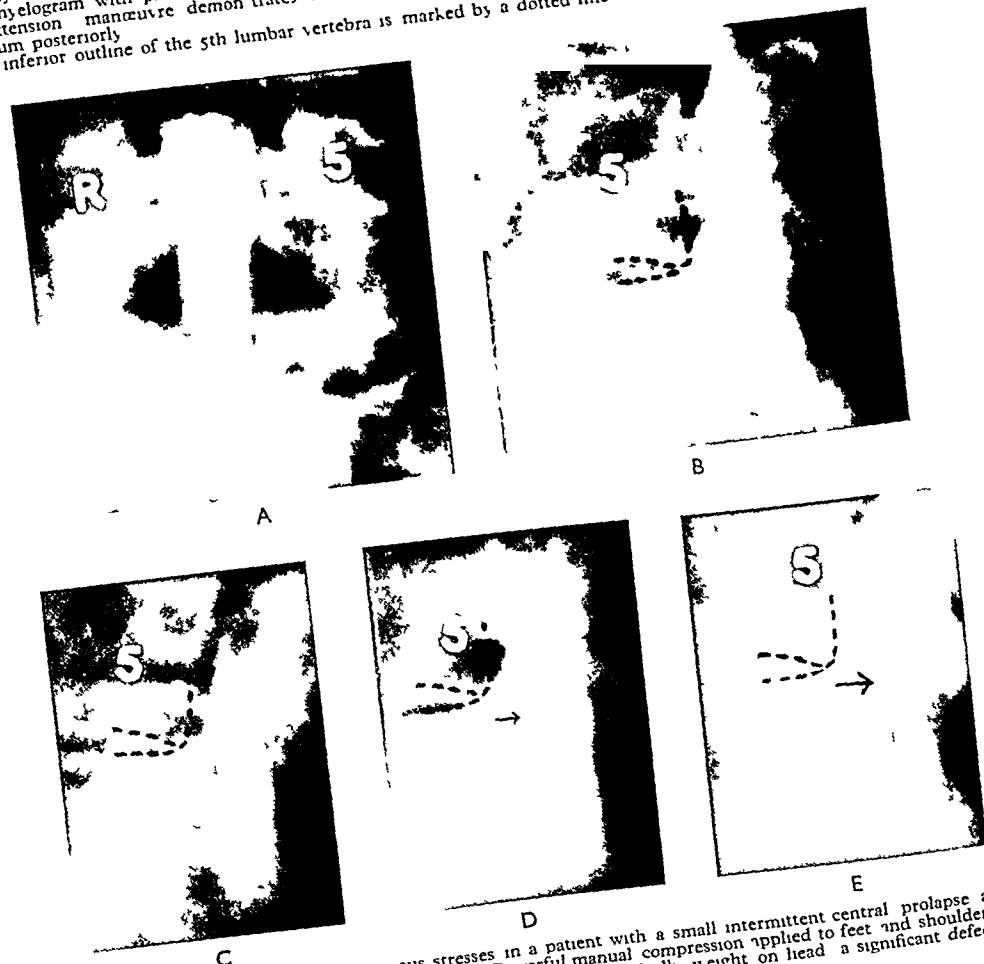


FIG. 210—Myelograms showing effects of various stresses in a patient with a small intermittent central prolapse at lumbosacral space. A, B, Routine myelograms show no abnormality. C, Powerful manual compression applied to feet and shoulders with patient prone produces negligible change. D, When patient stands erect bearing 60 lb weight on head a significant defect appears. E, Hyperextension manoeuvre with patient prone produces the most marked effect. The anteroposterior view was not affected by any of these procedures (—).

the tilting fluoroscopic table compared with those present when he is on the operating table, and that these differences may account for some of the discrepancies which formerly seemed apparent between the myelographic and the operative findings. The patient on the operating table usually has all his voluntary muscular tensions lessened by anaesthesia, while if he is placed horizontally with his hips and lumbar spine flexed, the interlaminar spaces and posterior margins of the disk spaces are stretched. Under these circumstances the strains involving the intervertebral disk are at their lowest, and consequently the affected disk may not bulge when exposed surgically. However, the pathological disk may be made to protrude by means of a simple manoeuvre, for if the operating table is broken so that the hips and lumbar spine are passively extended, the affected disk will usually bulge backwards (*Fig 208*).

It is disk protrusions of this type which we describe as 'intermittent'. These are probably identical with the 'concealed' disks referred to by Dandy (1941). Most cases of intermittent prolapse produce a positive defect on myelography, because the tensions resulting from muscular tone in the unanæsthetized patient are usually sufficient to make the disk protrude. Occasionally, however, myelography when performed in the ordinary way fails to reveal an abnormality, but if the patient who is lying prone then raises his head and shoulders off the table without disturbing the position of the lower half of his body, the prolapse becomes manifest. This manoeuvre is comparable to the one we perform at operation, and its effects are well illustrated in *Figs 209, 210*. In both instances the myelograms

defect was only seen in the prone-lateral projection. In *Fig 209* one may also note that not only did a midline disk prolapse reveal itself during the manoeuvre, but also that an indentation appeared on the posterior aspect of the thecal column in the position of the ligamentum flavum. The considerable narrowing of the subarachnoid space between the two indentations, anterior and posterior, can be measured by the distance the opaque column has been forced upwards. The appearances also suggest how nerve-roots may be compressed between a disk prolapse in front and the ligamentum flavum behind.

Both Eaglesham (1944) and Childe (1945) have published myelograms indicating that weight-bearing, too, may accentuate the size of a disk prolapse, as judged by the observation that the myelographic deformity may increase when the patient stands erect compared with when he lies prone. Knutsson (1942) and Childe (1945) also have noticed that extension of the spine tends to accentuate myelographic deformities due to disk protrusions. We feel, however, that extension of the spine is the more potent factor, because in our experience it is easier to exaggerate a myelographic defect by this means than it is by weight-bearing (*Fig 210*). Only a small proportion of prolapses are affected by either means, for often we have carried out our 'hyperextension' manoeuvre, and at other times have placed 70-lb. weights on a patient's head and shoulders, without appreciably affecting the size of the defects. We have even noticed that such procedures produced no effect on the prolapse of a patient examined with 24 hours of the onset of his first attack of pain.

It is too seldom realized that the strains imposed on the lumbar intervertebral disks vary greatly according to the posture and weight-bearing of the

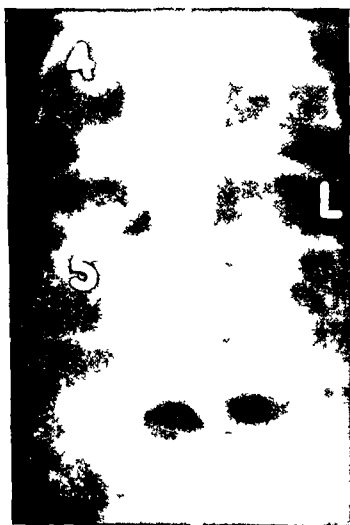


FIG 211—Myelogram showing disk prolapse at both 4th and 5th spaces. At 4th space central protrusion causing hour-glass constriction. At 5th space extrusion on right side displacing S 1 root pouch laterally and thecal column medially.

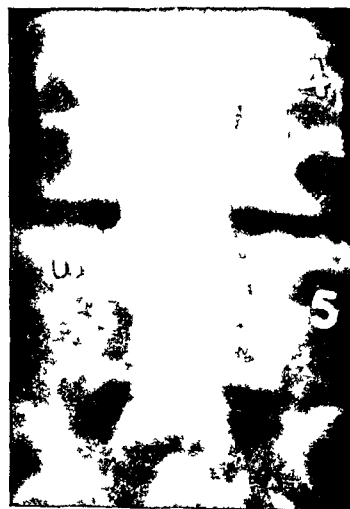


FIG 212—Myelogram showing orifice of L 5 root pouch on right side displaced slightly upwards, the result of an extrusion from the L 5 space.

taken in the ordinary way appeared normal, whereas those taken after hyperextension outlined a central prolapse of appreciable size. In *Fig 209* it may be noted that the anteroposterior as well as the prone-lateral views show defects, whereas in *Fig 210* the

patient, and that the size of a disk protrusion may alter with the stresses affecting the disk.

**3 Extrusions**—Extrusions may cause two characteristic myelographic appearances. They may displace root pouches instead of obliterating them, and they may cause defects in the thecal column at a

distance from the disk space. In Fig 211, for instance the first sacral root pouch is displaced outwards, while the second sacral root is deflected medially in its intrathecal course, at operation in this case a large extrusion of nuclear material was found wedged in the angle between the first sacral

column towards the opposite side, this was due to a large extrusion from the fifth disk

4 **Scarred Disks**—When a disk prolapse has been present for many years, secondary changes



FIG 213—Myelogram showing lateral defect of thecal column on left side extending up to L4 pedicle, caused by an extrusion from the 4th disk ( $\times$  )

nerve-root and the theca. In Fig 212 the orifice of the fifth lumbar pouch is elevated, and in this case an extrusion of the fifth lumbar disk had passed upwards alongside the theca to cause this deformity. In Fig 213 there is a lateral defect of the theca at a level between two disk spaces, this was due to an

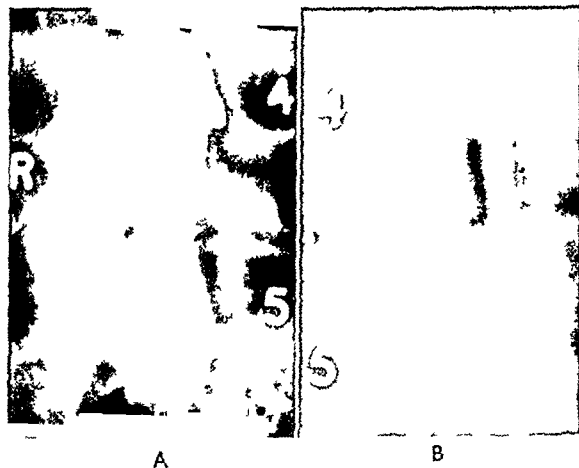


FIG 215—Myelogram of scarred disk causing symptoms. Note narrowed disk space. A, Anteroposterior view showing slight hour-glass construction. B, Prone-lateral view showing that indentation of theca is caused by bony outgrowths ( $\times$  )

extrusion of the fourth intervertebral disk which passed to become wedged between the theca medially and the fourth lumbar nerve and vertebral pedicle laterally. In Fig 214 there is a wide-based defect extending from the fifth up to the fourth lumbar disk, associated with a displacement of the thecal

column towards the opposite side, this was due to a large extrusion from the fifth disk. The disk space becomes narrowed, bony spurs develop at its margins, protruded nuclear material becomes absorbed, and the theca and the extrathecal nerve-root caught up by the scarring process becomes firmly adherent to the disk. Such a disk can usually be identified by scrutiny of the plain radiographs in conjunction with the myelograms. In the plain views the marked narrow-

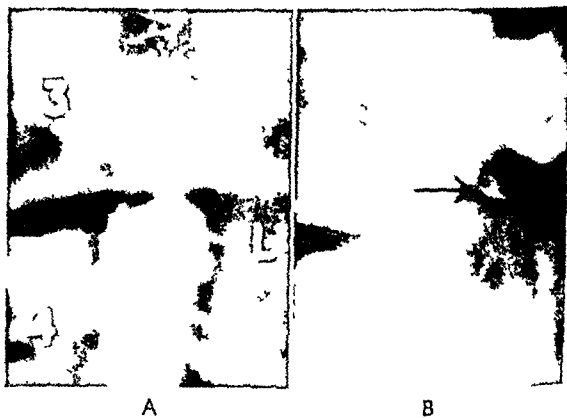


FIG 216—Scarred disk not apparently causing symptoms. A, Anteroposterior view of myelogram, showing large defect of thecal column. B, Plain lateral view, showing bony projection which caused this defect ( $\times$  )

ing of the disk space, its sclerotic edges, and the osteophytic outgrowths are seen, while in the myelogram the prone-lateral views show that any indentation coincides exactly with the bony projections, and is not caused by a soft-tissue protrusion (Figs 215, 216). Many scarred disks of this type do not cause symptoms.

# MYELOGRAPHY IN LUMBAR DISK LESIONS C INDIRECT EFFECTS OF DISK PROLAPSES

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1 Swollen Intrathecal Nerve-roots —Often the affected nerve-root is swollen for a variable distance proximal to the site of compression. This may be revealed not only by an absence of filling of

may develop occasionally at the level of a long-standing disk lesion, and produce an obstruction in the thecal column (Fig 219). This 'block', however, presents certain features by which it can be distinguished from a block produced by a midline extrathecal lesion on the one hand, and a large intrathecal tumour on the other. Thus in lateral



FIG 217 —Myelogram showing multiple disk protrusions —4th space central, and 5th space left lateral. The outline of the swollen S1 nerve-root can be traced within the thecal column for a distance of 3 cm above the 5th space. At operation this nerve-root was twice the normal calibre (x 3)



FIG 218 —Myelogram showing effects of left lateral prolapse at 5th space. Here the large intrathecal defect was produced by the left S1 nerve-root, swollen to four times its normal size. Its medial border is indicated by arrows (x 3)

the root pouch, but also by a band of radiolucence within the main thecal column which indicates the position of the swollen nerve-root (Figs 217, 218). We have observed congestion and swelling of individual nerve-roots within the theca on a number of occasions, and each time have found it to be associated with compression of the nerve-root by a

views there is no invagination of the anterior thecal wall such as occurs with midline disk prolapses, while in anteroposterior views the outline of the obstruction appears as a serrated edge, in contrast to the smooth edge which typifies a cauda equina tumour. This serrated edge is produced by seepage of contrast medium between the neighbouring roots of the cauda equina matted together with adhesions. A similar appearance is seen with blocks due to extrathecal compressions which crowd together the intrathecal nerve-roots.

## D MULTIPLE PROLAPSES

Multiple disk protrusions were demonstrated myelographically in 17 per cent of our cases (Figs 211, 217, 220). In two other instances a second lesion was found at operation which had not been detected on myelography. In one of these, however, a complete block was present at the fourth space, preventing an examination of the lumbosacral space, where the second lesion was situated. This advance information of the number of lesions present has often proved useful at operation, and has guided the surgeon to disk prolapses which otherwise might have been overlooked. Any of the types of prolapse described may occur in combination. This is readily understood, since ordinary degenerative processes are the primary cause of the condition, and these processes affect to varying degrees all the intervertebral disks. Many, if not most, disk protrusions in the lumbar region do not cause pressure symptoms and therefore at operation only those protrusions should be dealt with which can be correlated with the clinical features of the case.



FIG 219 —Block at 4th lumbar space due to leptomeningeal adhesions. Patient was in head low position. Note serrated edge caudal to block. (A prone lateral view showed serrations with no anterior indentation of theca at this level) (x 3)

disk protrusion lower down. An analogous swelling of nerve-trunks proximal to the site of a compressing lesion has been observed experimentally by Denny-Brown and Brenner (1944).

2 Arachnoiditis —Leptomeningeal adhesions matting together the elements of the cauda equina

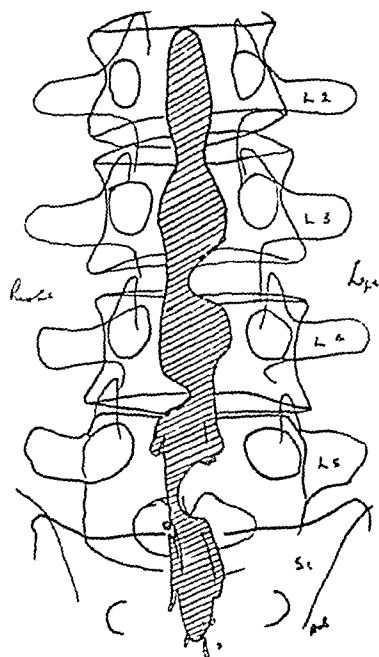


FIG 220—Composite tracing showing lateral disk protrusions at 3rd, 4th, and 5th spaces ( $\times 3$ )

### E 'HYPERTROPHIED' LIGAMENTUM FLAVUM

Our experiences in regard to this condition has been largely of a negative character, but in view of the diversity of opinion which has been expressed concerning the nature and significance of these lesions, some observations made during myelography will be recorded. In this series we have found no myelographic evidence of hypertrophy of the ligamentum flavum in the lower lumbar region, nor did we establish its existence at operation. The myelographic appearances adduced by Towne and Reichert (1931), Hampton and Robinson (1936), and Brown (1938), as evidence of this condition were based upon anteroposterior views only, and show nothing which in our experience might not be caused by a disk lesion alone. Camp (1939, 1941) published prone-lateral as well as anteroposterior views of his myelogram, but the deformity which he believes to be characteristic of hypertrophy of the ligamentum flavum, is (to quote him) 'an indentation of the posterior aspect of the opaque column in addition to the anterior indentation due to the prolapse itself'. This posterior defect, present only when the spine was extended, coincided with the position of the ligamentum flavum, which at operation seemed to be of normal size and texture. In our view this appearance is due partly to the bulging of normal ligaments when they relax on extension of the spine (Knutsson, 1942). A second factor, both in our case and in the one illustrated by Camp (1939, 1941), is that the disk prolapse has pushed the theca, here relatively mobile, backwards until it comes into contact with and outlines these ligaments.

These and other observations lead us to believe that true hypertrophy of the ligamentum flavum,

if it occurs at all, must be a rare cause of symptoms. A prolapsed disk, however, may displace nerve-roots backwards to compress them against normal ligaments.

### F ARTEFACTS

Unless care is taken with the injection of contrast medium, curious and misleading appearances may occur which may render the myelogram worthless. These appearances are due to the presence of cerebrospinal fluid or of contrast medium outside the subarachnoid space, and may be caused either by faulty injection or by subsequent leakage. Leakage of cerebrospinal fluid through a puncture in the arachnoid gives rise to two types of artefact. If a large amount of fluid escapes into the subdural space, the subarachnoid space is compressed around the cauda equina and the opaque oil within it appears as a long thin column (Fig 221). If only a small amount escapes, localized and irregular filling defects are produced in the thecal column (Fig 222). Eaglesham (1944) has illustrated the mechanism of these subdural leaks of cerebrospinal fluid.



FIG 221—Attenuated thecal column due to generalized leakage of cerebrospinal fluid into subdural space ( $\times 3$ )

If contrast medium leaks into the subdural space it may remain in a mass, which on screening may seem to move sluggishly along the spinal canal the table is tilted, while any medium in the subarachnoid space rapidly overtakes and passes (Fig 223). If medium escapes into the extradural tissues it may pass along the track of the lumbar puncture needle (Fig 224). It may also seep along the epidural spaces, producing the startling appearance of Fig 225.

Artefacts of minor degree may not vitiate the examination, but when they are gross myelography becomes impossible. In our series most artefacts occurred at a period when several persons employing varying technique were carrying out the injection.

As a consequence we learnt that several precautions must be observed —

a Lumbar puncture should be performed with the patient lying horizontal. If the patient is in the

c When introducing the contrast medium it is important that a lumbar-puncture needle of fine calibre be used, and that the dura and arachnoid be pierced once only

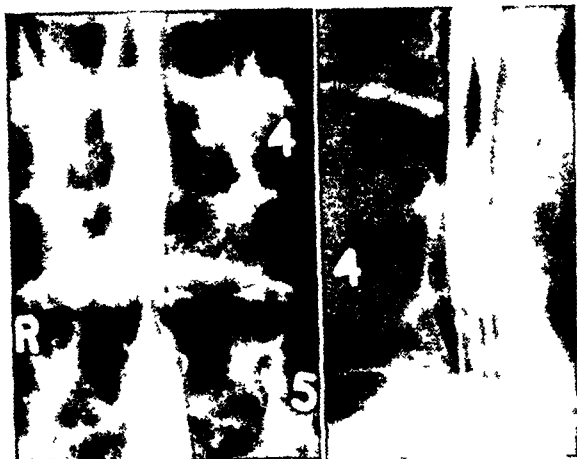


FIG 222 —Effect of localized collection of cerebrospinal fluid in subdural space producing compression of subarachnoid space. The lateral view eliminated the presence of a disk lesion. At operation the nerve roots appeared normal and there was no arachnoiditis ( $\times 7$ )



FIG 224 —Escape of contrast medium into epidural space and along lumbar-puncture needle track ( $\times 1$ )

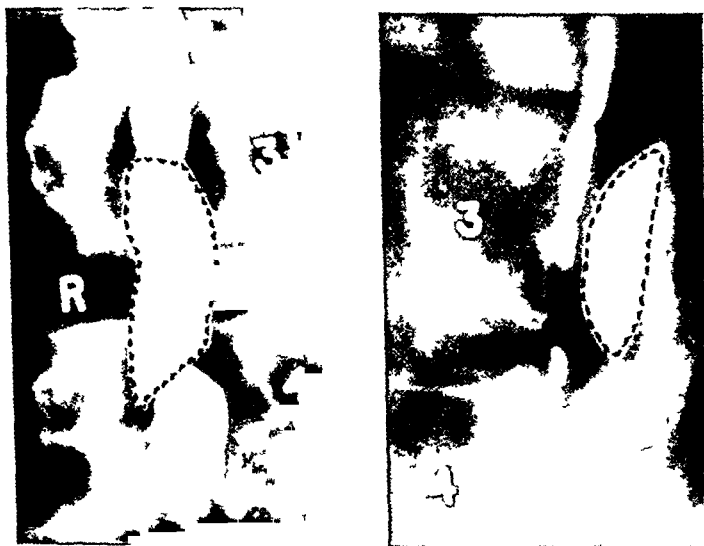


FIG 223 —A localized collection of contrast medium in subdural space. The rest of the medium is in the subarachnoid space ( $\times 3$ )



FIG 225 —Permeation of contrast medium throughout epidural spaces ( $\times 3$ )

sitting position, the augmented pressure of the cerebrospinal fluid in the lumbar sac favours leakage into the subdural and extradural spaces

b The injection should not be made within several days of a previous spinal puncture. On occasions when myelography is repeated we have a gradual loss of medium from the subarachnoid into the subdural space, indicating that there has been a perforation in the arachnoid which has remained open for some days. As a result of these and other observations we believe that leakage of cerebrospinal fluid through puncture holes in the theca often occurs following lumbar puncture, and incidentally is the fundamental cause of post-puncture headache

d The examination should be made soon after the injection, the patient meanwhile remaining horizontal

When these simple precautions were observed, we found that artefacts were eliminated, and have since performed myelography in more than a hundred cases without encountering them

### DISCUSSION

Myelography can only become established as a routine procedure in the investigation of lumbar intervertebral disk lesions if it can be shown to be innocuous, to afford a reasonably accurate method of localizing lesions, and to give helpful information

which otherwise would not be available to the surgeon planning operation. We believe that myelography satisfies these requirements.

**First Requirement The Safety of the Procedure**—In none of our cases were any untoward effects seen which could be attributed to myelography. Strong objection has been raised to this procedure in that it involves the introduction into the subarachnoid space of a foreign substance, which may persist for a long time, if not indefinitely. Some authorities indeed have reported undesirable reactions, but we have not observed these. The reason may be that we employed only contrast media of established excellence (pantopaque and lipiodol Lafay), and if these were not available, we avoided the procedure rather than use substitutes of the harmlessness of which we were uncertain. Pantopaque we found to be slowly absorbed at a rate of two-thirds of its volume in a year. Lipiodol, however, is not absorbed. Until other and better substances become available, we feel reasonably safe in continuing to employ either pantopaque or lipiodol Lafay.

**Second Requirement The Accuracy of Procedure**—The second requirement concerns the accuracy of myelography in establishing the presence of a lesion. We feel that with experience the level and site of a prolapse can be deduced correctly, also the presence of multiple prolapses can be determined and sometimes the pathological type of the lesion forecast.

In order to study the value of myelography statistically we analysed our observations in the 86 cases out of our series which had technically satisfactory myelograms. Those cases were excluded in which the myelograms were worthless because of artefacts caused by a faulty technique or in which myelography was not performed because of temporary shortages of suitable contrast media. Of these 86 cases, 76 (88 per cent) showed myelographic appearances which were interpreted as pathological, while 10 (12 per cent) were considered normal. In all except 1 case one or more disk lesions were subsequently established at operation.

In the 76 cases in which the myelograms showed an abnormality, the anticipated lesion was subsequently found at operation in all but 2 instances. In the first of these two cases which proved exceptions, the myelogram had suggested that prolapses were present at each of the lower three lumbar spaces, one being of gross proportions and the other two only slight. At operation only the gross lesion was demonstrated, while the other two disks seemed normal. The operative exposure, however, was restricted to a peep-hole interlaminar approach at each space, and subsequently the patient, although improved, still had persistent though not troublesome backache. In the second case, one of intractable low back pain without sciatica, a central disk prolapse was indicated by myelography, but the disk when exposed through an interlaminar approach seemed normal. This was the only negative surgical exploration in our series, but as the patient was not benefited, it is possible here also that a disk lesion was overlooked at operation.

Thus when the myelogram is positive the presence and level of a disk protrusion are indicated with almost complete accuracy (74 out of 76 cases,

or 98 per cent). In the 74 cases which were subsequently confirmed at operation, a prolapse was demonstrated myelographically at the fourth lumbar space in 46 cases and at the fifth space in 43 cases. In 14 multiple protrusions were disclosed, including 3 at the third lumbar space. Moreover, in nearly all these cases there was a high correlation between the site of the prolapse in relation to the theca and nerve-roots, as suggested by myelography, and that established at operation. The type of prolapse, however, could only be foretold approximately, but this information is rather a refinement of diagnosis, for the more fundamental information concerns level and site.

In each of the 10 cases in which the myelograms were negative a disk lesion was shown to be present at operation. Two cases of this group, however, were instances of multiple protrusions, in which only the larger lesion had been revealed radiologically (in one the major lesion caused a complete block which precluded examination of some of the lumbar spaces), while in a third case with an intermittent type of prolapse at the lumbosacral space a slight but definite degree of spondylolisthesis was present which may also have been responsible for symptoms. This reduces the number of negative myelograms to 7, and of these, 2 were examples of disk projection situated far laterally at the fifth lumbar space, while 5 were examples of intermittent prolapses. The 2 disk projections presumably did not affect the myelograms because they compressed the first sacral nerve-roots at points below the level of filling of the root pouches, and in this connexion the observation of Arbuckle, Sheldon, and Pudenz (1945) that, if the thecal column is narrow, it may not be affected by a lateral protrusion, is also relevant. The 5 examples of intermittent prolapse (3 at the fifth space and 2 at the fourth) may possibly have been overlooked, because in none of them did we carry out the hyperextension manoeuvre on the X-ray table, as we did not discover it until a later stage. Had we explored it earlier we might have had fewer normal myelograms. It must be remembered, of course, that most cases of intermittent prolapse produce filling defects on myelography similar to disk projections.

Thus in 12 per cent of cases in our series the myelograms were normal although disk lesions were present. It is possible that some lesions were missed through inexperience, but the fact remains that a negative myelogram does not exclude a disk lesion. On the other hand, a positive myelogram will demonstrate a disk lesion with great accuracy, not only as regards its level, but also as regards its site in relation to the theca and the nerve-roots.

**Third Requirement Useful Information**—The third question to consider is whether myelography affords useful information which cannot otherwise be obtained before operation. We have just shown how the procedure indicates with reasonable accuracy the level of the pathological disk, and so enables the surgeon to expose and explore it with the minimum of delay and trauma. In one of our cases, which had been explored elsewhere without benefit, the myelogram showed that the wrong disk had been exposed, and that the offending disk had not been disturbed. Preliminary myelography would probably have prevented this unfortunate

error Similarly it discloses the presence of multiple prolapses, which in our series occurred in the lower lumbar region in 17 per cent

A most useful piece of information is whether a disk prolapse is centrally or laterally placed In our series approximately a third of the prolapses were centrally placed while two-thirds were laterally placed We learnt from bitter experience that with a central prolapse it is often impossible to remove satisfactorily all the degenerated disk tissue from only one side of the theca, and that it is then necessary to expose and curette the affected disk from the opposite side as well In the early stages of our work several of our patients after operation still had symptoms, such as severe backache or severe pain down the opposite leg These were mostly examples of central prolapse where a unilateral procedure had been carried out When at a second operation we came to explore the affected disk from the other side, we were often surprised to find a large amount of degenerated disk material still present in the disk space, and the removal of this usually relieved the symptoms Consequently we now explore these central prolapses from both sides of the theca, and the knowledge which myelography affords of the situation of the lesion thus helps in planning operation

Another advantage of myelography is that it assists in distinguishing tumours of the cauda equina which may be simulating disk lesions We have met with only one example, an extrathecal hydatid cyst at the lumbosacral region which was causing sciatica Love (1944), however, reports that at the Mayo Clinic, during a period when 100 consecutive patients underwent operation for protruded intervertebral disks, 8 cases of spinal tumour producing a 'disk syndrome' were encountered, and that a correct diagnosis was made pre-operatively in these cases largely because spinal puncture and contrast myelography were undertaken before operation

In the absence of myelography a surgeon should expose both lower lumbar intervertebral disks from both sides of the theca if he is to avoid overlooking a lesion or dealing with one incompletely We followed this practice when the myelograms were normal or were obscured by artefacts, but it is not a good policy to follow as a routine, because it means that frequently an unnecessary amount of surgical trauma is inflicted upon the vertebral column To expose a disk adequately so that one can be certain it is normal, often requires the removal of the spine and lamina, for the exposure which is gained by an interlaminar approach is too restricted for the proper visualization of many central prolapses Again, if a tumour is present the exposure has to be even wider Knowledge beforehand of what he can reasonably expect to find at operation usually enables the surgeon to deal with a lesion with the minimum of trauma and delay

### CONCLUSIONS

For these many reasons we believe that myelography is worthwhile as a routine diagnostic procedure in lumbar intervertebral disc lesions It is, however, important to realize that a myelographic defect indicating a disk lesion is not of itself sufficient justification for surgical intervention, for a disk protrusion may be symptomless Thus

we have examined the lumbosacral theca in cases in which myelography was being performed for the diagnosis of a lesion in the cervical and lumbar regions, and occasionally we have found evidence of a lumbar protrusion without associated symptoms Again, in cases of sciatica which have resolved spontaneously, we have found that if myelography be repeated the defect indicating a disk lesion may persist long after all symptoms have subsided

Myelography, therefore, should never displace clinical methods of investigation as the basis of diagnosis of intervertebral disk lesions It serves, however, to confirm and amplify the clinical findings We believe that myelography should play as important a role in the routine investigation of these lesions as does a barium meal in gastric disorders We have been impressed by the fact that frequently myelography adds details to the pre-operative picture which subsequently are of assistance in treatment Although media even more suitable than pantopaque will be introduced in the future, it seems unlikely that the principles underlying myelography will change

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## A CONCEPT OF PARALYTIC ILEUS: A CLINICAL STUDY

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*"Oft the teeming earth is with a kind of colic pinch'd and vexed by the imprisonment of unruly wind within"*—Shakespeare, HENRY IV, Part I

## I

## INTRODUCTION

A gastro-intestinal complex—distension, gas pains, constipation—commonly follows many operations on the abdomen and sometimes operations in other parts of the body. As a rule, it is a temporary disturbance of intestinal motor function, but it may merge into a serious condition in which the patient is greatly distended, is vomiting continuously, and is completely constipated, that is, it may merge into a condition which is known as paralytic ileus\*.

For the purposes of this study, 'paralytic ileus' is used to indicate all conditions characterized by distension, constipation, vomiting, and lack of bowel movements.

The present article is a study of this gastro-intestinal complex undertaken to see whether it might be prevented by any change in routine pre- and post-operative treatment, and it is also a study of the treatment of developed paralytic ileus.

From this literary, clinical, and experimental study it is hoped to establish these main points—

- 1 That 'true' or idiopathic paralytic ileus is rare,
- 2 That many cases which are regarded as 'true' or idiopathic post-operative paralytic ileus are caused by intra-abdominal infection of some sort,
- 3 That there are three definite stages of ileus—an early, a middle, and a late—paralytic—ileus,
- 4 That intestinal movements are present in the early stages of the ileus, but in the late stage they are absent,
- 5 That a regimen of treatment based on each stage should be laid down.

## MATERIAL STUDIED

The study was approached from several different angles after available recent literature had been studied.

1 The records and histories over a period of six years of 43 consecutive intestinal intubations with the Miller-Abbott tube, and a number of cases seen in consultation, but which had not required intubation, were examined and analysed.

2 Observations on intestinal movements, and the return of intestinal movements after ileus, with recording apparatus connected to the balloon of the Miller-Abbott tube were made, with and without the use of drugs. At first a recording tambour was used to record the movements on smoked paper fastened around a pie-dish mounted on an electric clock which revolved once in twelve hours. However, as most

of the patients were desperately ill and required considerable nursing attention, many of the records were brushed off by the nursing staff. Then a commercial clock-face ink-recording barometric type of pressure recorder was used, and, with the pointer loaded, was found to be satisfactory and "nurse proof". Most of the records included are from this apparatus, in an effort to demonstrate instrumentally what was observed clinically. Difficulties of recording in these sick patients were added to by the fact that coughing, vomiting, straining, etc., and all attempted movements caused sudden changes of intra-abdominal pressure which were recorded as "spikes" on the slowly-moving drum, and in Fig 229, a, the effects of these factors on the records is shown.

3 In two patients who had ileostomies, records were made from balloons placed in the ileostomies.

4 X-ray studies were made of the effect of some drugs on bowel motility in normal subjects.

5 Auscultation of the abdomen was made on all cases seen, and also on a number of cases in the immediate post-operative phase following appendectomy and other abdominal operations, the return of movements being particularly noted.

6 Observations were made on a number of patients in whom gross soiling of the peritoneal cavity had caused paralytic ileus, and in whom morphine was given prophylactically.

7 The effect on bowel movement of heat on the abdomen and turpentine stupes, and of some of the commonly used drugs, was also studied.

8 In two patients with ileostomies and a separate "defunctioned" colon, the effect of colonic irrigation on small bowel movement was observed.

9 In two patients in whom the Miller-Abbott tube had been introduced through a jejunostomy, the effect of gastric distension on small-bowel motility was observed.

## CAUSES OF ILEUS—AND OF PARALYTIC ILEUS

A table of the causes of ileus has been put forward by Ochsner and Gage (see Appendix). The classification of the causes of paralytic ileus, however, is perhaps more appropriately set out under the three following headings: (1) 'True' or idiopathic paralytic ileus, (2) Paralytic ileus arising from medical diseases, (3) Paralytic ileus the result of surgical operations.

## I 'TRUE' OR IDIOPATHIC PARALYTIC ILEUS

Idiopathic or paralytic ileus of unknown cause may be due to over-action of the sympathetic nervous system, and thus it may arise (a) as a result of stimulation, or (b) following reflex inhibition.

\* Ileus is defined vaguely as 'a kind of colic', and 'ilic passion' as intestinal colic. Thus the word has wandered far from its original or earlier meaning, for a 'paralytic colic' seems a contradiction.

**a As a Result of Stimulation**—This is probably the cause of the frequent development of paralytic ileus in cases of retroperitoneal hæmatomata (Karabin, 1942). This origin is exemplified in the following case —

*Example 1* —A male, aged about 30 years, was hit by a car and suffered a fracture of the pelvis. When admitted he was very shocked and was given intravenous serum. Catheterization showed that there was blood in his urethra, but the catheter passed into his bladder. On the third day he became greatly distended and there was no result from a rectal tube, pituitrin, or enemas. He vomited copious quantities of brownish fluid. A Miller-Abbott tube was passed and from the various tests (John Devine, 1945) it appeared to be beyond the pylorus. However, he became completely irrational and pulled it out. The tube was put back several times in the night, but the next morning he died. Post-mortem examination showed a retroperitoneal hæmatoma and enormous distension of the small and large bowel with clear intraperitoneal fluid. There were no evidences of peritonitis.

**b Idiopathic Paralytic Ileus caused as a Result of Reflex Inhibition of Gut Movement**

—This probably occurs through the sympathetic system. The reflex may arise from a slight blow on the abdomen, peritoneal irritation, an abscess, acute appendicitis, or even from just the opening of the abdomen.

In this type of paralytic ileus it has been the experience of the author that a spinal anæsthetic initiates peristalsis—at any rate temporarily—and that it is not inhibited during the subsequent operation.

In addition to the types above described, there is, also, following all abdominal operations, a reflex inhibition of intestinal movements. Abdominal auscultations carried out by the author, after operations of a routine type, showed that the first sound to be heard in the abdomen occurred between three and eight hours following the operation, in other words, there was a temporary phase of ileus. Moir (1943) points out that opening of the abdomen itself produces a period of an "active" phase of ileus. This has been confirmed by others. Davis and Hansen (1945) gave barium to patients before operations for appendicectomy performed under spinal anæsthesia. They showed that following the operation there was a definite decrease in intestinal movements and a delay in emptying the stomach. Wakum and Mann (1943) found that ether anæsthesia and exploratory laparotomy stopped alimentary tract movement for at least four hours. Ether anæsthesia and an operation for bowel anastomosis caused cessation of intestinal movement (i.e., ileus) for at least twenty-four hours, it was seventy-two hours before weak peristaltic waves were recorded, but after the fifth day no detectable differences could be seen between records of intestinal activities made prior to operation. Even then, however, there was still some inhibition of intestinal movement in the sectioned loop.

The time of recovery from this post-operative period of active ileus varies greatly, depending on the operative procedure, the anæsthetic among other factors. Observations by the author suggest that recovery from this 'active' ileus closely corresponds

to the recovery from 'paralytic' ileus, and for this reason deserves careful study.

It is probable that a continuation of this very variable period of 'active' ileus, enhanced by either a mild unnoticed post-operative infection, or non-physiological treatment, may, in a number of cases, be the origin of complete post-operative paralytic ileus.

A post-operative ileus is frequently found associated with a post-operative difficulty in voiding urine. Observations of the author show that urinary retention and post-operative ileus tend to occur in the same type of patient—i.e., one who may have a hyperactive 'sympathetic' system. The following case illustrates such an association —

*Example 2* —Seven days after an operation for a left inguinal hernia, a man aged 45, who had had to be repeatedly catheterized, became distended. He began to vomit fæculent material and had hiccups and a dry brown tongue. A Miller-Abbott tube was passed, and in the first twenty-four hours 38 oz of fæculent fluid and a great deal of gas were withdrawn, relieving his distension. Even then he still had some difficulty with micturition, but his convalescence was uneventful.

In this case when the tube was 3 ft past the pylorus peristalsis was very slight, but following one pint of serum intravenously peristalsis became much more marked and frequent and the tube drained much greater quantities of material and air.

A full bladder or inflammation or stimulation due to other causes of the kidneys or bladder may cause inhibition of movement of the ileum and increase of gas in the intestine (Allen and Jamison, 1940; Svier and Mann, 1943).

The following case illustrates the immediate cessation of bowel movements resulting from placing gauze packs in the abdomen.

*Example 3* —A woman of 25 years had a Gilliam suspension of the uterus performed. Following operation, intraperitoneal bleeding occurred, and two days later the abdomen was reopened but no bleeding point was found. The pelvis was packed with gauze and the patient transfused. When seen some six hours later she had become markedly distended. A tube was substituted for the packing and the distension became noticeably less. As auscultation revealed no borborygmi a Miller-Abbott tube was passed. She was much improved for a week. Then she developed fever, rigidity, slight jaundice, and again distension. Infection of the intraperitoneal blood was assumed, and again the Miller-Abbott tube was passed and chemotherapy commenced. She recovered from this phase, but on the fourteenth day began to get definite intestinal colic, and a mechanical obstruction of the small bowel was correctly diagnosed. Before the operation a Miller-Abbott tube was introduced through a jejunostomy, and when the distension had thus been relieved the abdomen was opened and multiple dense adhesions were encountered. Division of these and ileostomy were performed. She died two days later from pneumonia.

Cathartics have an effect on the movements of the small bowel. Alvarez (1918) has shown that following purgation there is a period of intestinal atony and immobility. If, in pre-operative preparation, this period is allowed to coincide with an intestinal operation, the depression of bowel motility and therefore the post-operative ileus is increased. It is possible that fewer cases of post-operative

paralytic ileus occur now because routine purgative pre-operative preparation is not carried out

A paralytic ileus, possibly of idiopathic type, may occasionally follow the most trivial injuries or procedures, and it is impossible to say whether it is nervous in origin. For example —

*Example 4* — A middle-aged woman with a long history of hysteria and neurosis had a minor orthopaedic procedure performed on her foot. Ten days later she gradually developed abdominal distension and occasionally vomited. The abdomen became silent. Priturin and enemas failed to relieve the distension, so a Miller-Abbott tube was passed and gas and fluid evacuated. It was removed after several days, and though she sometimes had a return of the distension, all investigations (including barium meal and enema) were negative. She has remained reasonably well for the last six months.

The author has seen paralytic ileus follow the application of a plaster hip spica for a compound fracture of the femur due to a bullet wound.

It is usual in all cases of paralytic ileus of the 'idiopathic' or 'peritonitic' type that the distension is relieved by the Miller-Abbott tube and recommencement of bowel movements carry down the tube. This removal of distension results in the return of local bowel movement. This is agreed by all observers and has been verified personally. A logical inference from this is that in some cases the distension may be at least the initial cause of the lack of motility and not, as is usually stated, that bowel paralysis is secondary to the distension, though, of course, the balloon on the tube is a powerful stimulus to bowel contraction. This fundamental conception does not explain cases of post-operative 'active' ileus where there may be no distension and no movement. It does, however, seem probable by analogy, as overstretching of other involuntary muscular mechanisms such as in the bladder and sphincter ani is followed by a temporary or partial paralysis of bladder or sphincter. Another example is the improvement in the heart's action if it is dilated by venesection.

If this reasoning is true, then the key to the prevention of post-operative ileus is the prevention of post-operative distension.

Paralytic ileus may occasionally be due to hypoproteinaemia, as when the serum protein concentration is low the motility of the bowel is also considerably lowered, possibly due to bowel oedema. After serum transfusion the motility increases (Leigh, 1942; Barden, Thompson, Ravdin, and Frank, 1938, and Devine, 1938).

## 2 PARALYTIC ILEUS CAUSED BY MEDICAL DISEASES

A paralytic ileus can be brought about by any form of general infection or general toxæmia. It also occurs in uræmia, the late stages of pneumonia, and in the terminal stages of other medical diseases, e.g., it may be the terminal stage of a case of liver failure, as in the following case —

*Example 5* — An elderly man had an operation for the removal of stones from the common bile-duct. He had been continually jaundiced for one and a half years and intermittently for fifteen years. After the operation he developed liver failure, became distended, and had no

bowel movements. Distension was removed by the passage of a Miller-Abbott tube, but he died in delirium a week later.

## 3 PARALYTIC ILEUS CAUSED BY SURGICAL DISEASES

It may be the result of —

1 Intestinal obstruction, mechanical or otherwise, because long-continued distension leads to bowel paralysis.

2 Paralysis of the bowel from the presence in the peritoneal cavity of pus, urine, blood, bile, gastric, duodenal, or intestinal contents.

In some cases in the series studied, one loop of the intestine was bathed by pus in the pelvis and produced intestinal obstruction from the local paralysed segment of bowel which, after some time, caused paralysis as a result of ascending distension of the remaining intestine. This was found to be a more common type of 'paralytic ileus' than the so-called 'idiopathic' type, and complete recovery followed drainage of the usual cause, viz., a pelvic abscess. In the early stages of these cases borborygmi were increased above, but in the late stages the abdomen was silent. A paralysed loop of intestine was causing obstruction.

The following case histories illustrate conditions of ileus which were apparently infective in origin. One also illustrates the fact that the establishment of a condition of ileus followed stimulative treatment —

*Example 6* — A middle-aged married woman had had a hysterectomy five days before I saw her. At the operation it had been found that she had an infected polypus in the cervix and this was closed over with difficulty. She had a slight rise in temperature after her operation and began to get distended on the third day. She was given priturin with only a small result, but with relief of the distension. She again became distended, and again was given priturin with the same result. Each time she became a little more distended after the priturin. By the fifth day she was very distended, and had a resonant abdomen. She had great difficulty in breathing and looked very ill. She had been having intravenous fluid, but no serum.

On examination she still had many borborygmi, and it was concluded from the history and physical signs that she probably had some loops of small bowel lying in an infected area in the pelvis. A Miller-Abbott tube was passed and 240 oz. of fluid was withdrawn in twenty-four hours. Distension was thus relieved and serum was given at the same time; her general condition improved. The following day a posterior colpotomy allowed pus to be drained from the pouch of Douglas. Following this, her convalescence was uneventful except for pneumonia, which was treated with penicillin.

While the tube was in position, a recording apparatus was connected to the balloon lumen and it was found that penicillin had no effect on bowel movement, but barbiturates considerably lessened them, and no effect could be observed with  $\frac{1}{2}$  gr of morphine.

*Example 7* — A woman, 30 years of age, had had a miscarriage many years before, and following this had been unable to have children. A salpingostomy was done, much against the wish of the gynaecologist who performed the operation, but the patient insisted on taking the risk of opening up the old infected tissue. Following the operation she had fever varying between 99.4° and 100.2°, and during the first two days vomited gastric contents. On the third day she began to vomit intestinal contents.

When I saw her on the fifth day she was vomiting dark-brown faeculent material in large quantities. She was distended and on auscultation her abdomen was silent. She looked very ill. Per vaginam she had tenderness over the uterus, but no mass was palpable. The condition was diagnosed as one of infection of a loop of bowel in the pelvis which had caused complete paralytic ileus. A Miller-Abbott tube was passed with relief of the distension, and at the same time sulphonamides and penicillin were commenced. After forty-eight hours the balloon of the tube was deflated and the tube withdrawn to the 2-ft mark. She again became distended and again the balloon was inflated and allowed to pass through the intestine. Five days after the first intubation, that is, ten days after operation, she commenced to have frequent loose bowel action. Convalescence from then on was uneventful.

**Example 8**—A middle-aged woman with a placenta praevia had had a lower segment Caesarean section done six days before being seen. After this she became distended and streptococci were cultured from the vaginal discharge. She had a high temperature from the third to the sixth day and penicillin had made no difference to her condition. When first seen she was very distended, slightly jaundiced, with a pulse of 130, and was hiccoughing and apathetic in appearance. There were no sounds to be heard at all in the abdominal cavity. The serum protein was 5.7. She was given three litres of serum and a Miller-Abbott tube was passed. This drew off 180 oz of fluid in the first sixteen hours. Her condition improved rapidly and the convalescence was uneventful.

**Example 9**—A woman about 55 years of age had had an operation for bilateral malignant ovarian cysts five days before being seen. Following the operation she had a steep rise in temperature and on the third day commenced to have distension and vomiting. By the seventh day she was very distended, had difficulty in breathing, and was slightly cyanotic in colour. The serum protein was 6.4. On auscultation of the abdomen many gurgling sounds were heard high up, but the hypogastrium was silent. It was concluded that she had a pelvic peritonitis with some loops of small bowel in it, and she was given two litres of serum and a Miller-Abbott tube was passed. Penicillin and sulphonamides were also given. In the first twelve hours 40 oz of fluid and a large amount of gas were aspirated by the tube and her distension disappeared by next morning; her bowels commenced to act the next day. Convalescence was uneventful.

Here is an example of ileus due to general peritonitis—

**Example 10**—An elderly man who had had an excision of a diverticulosis with five sinuses, had an obvious peritonitis for which chemotherapy and intubation were employed, but despite the fact that the distension was relieved and sounds were again heard in a previously silent abdomen, death occurred on the tenth post-operative day.

The following case also illustrates ileus from peritonitis, and the fact that wash-outs through an ileostomy, while increasing bowel movements, may actually increase distension when given at the wrong 'stage' of bowel movements.

**Example 11**—A middle-aged man who had had a carcinoma of the ascending colon developed a leak from the suture line of the ileum to the transverse colon. The abdomen was opened and the leaking area exteriorized and ileostomy done. A Miller-Abbott tube was then passed to relieve his distension, and, though it was successful in this, he developed auricular fibrillation the

next day, became irrational, and finally died. It was noticed in this case that wash-outs through the ileostomy markedly increased his distension.

## THE PATHOLOGICAL PHYSIOLOGY AND THE PATHOLOGY OF PARALYTIC ILEUS

Some idea of the frequency of paralytic ileus as a cause of death may be gathered from the fact that from the Royal Adelaide Hospital 10 cases were found in 1000 post-mortem examinations (1944, *Med sci Arch Adelaide Hosp*).

At post-mortem examination all that is found in a case of 'true' paralytic ileus is some thin intra-peritoneal fluid and a large mass of distended small bowel filled mainly with gas, and the length of the intestines is markedly diminished.

In paralytic ileus the bowel wall is thin, dusky, and oedematous, suggesting obstruction to the venous return. Distension by itself can produce venous obstruction. A pressure above 55–65 mm Hg within the gut causes pressure on the veins which encircle the ileum, interferes with the absorption of gas and fluid, and leads to more distension.

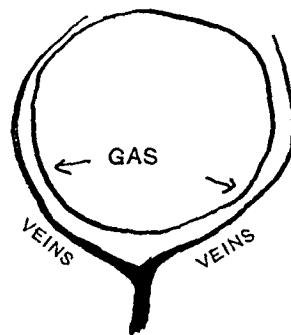


FIG 226—To show how increasing distension causes pressure on the veins and interferes with absorption from the bowel.

(Wangensteen, 1942). A vicious circle is thus brought about (Fig 226). Greater distension can even cause arterial compression.

The gas in the bowel of paralytic ileus is partly nitrogen, coming from swallowed air (Wangensteen, 1942), and partly carbon dioxide which is normally 4 per cent. The percentage of nitrogen is from 60 to 80. An important relevant observation is that the normal small intestine can absorb about 2500 c.c. of carbon dioxide and about 1300 c.c. of other gases per hour (McIver, Redfield, and Benedict, 1926; Davis and Hansen, 1945). These workers showed that most of the gas in the bowel following an anaesthetic is swallowed air. They proved that barium given to patients before operations for appendicectomy was not passed out of the stomach as quickly as when no operation had been performed. Thus they come to the conclusion that after operations gas is not passed along the bowel for expulsion, and that it accumulates and gives rise to pain.

The fluid in the bowel of paralytic ileus is thin, brownish, and flaky. The greater part of it is probably poured into the intestinal tracts in the form of saliva, gastric juice, bile, and pancreatic and intestinal secretions. This normally amounts to

from  $7\frac{1}{2}$  to 10 litres per day (Rowntree, 1922, and Gamble, quoted by Bockus, 1944) This fluid is toxic Injection of either the contents of the normal or of the obstructed bowel into the veins of experimental animals can be fatal This, however, does not prove that a toxin is the cause of death in cases of paralytic ileus

### THE EFFECTS OF DISTENSION OF THE BOWEL

The effects of distension can be local or general

**Local Effects**—Multiplication of gas-forming bacilli, such as *B. Welchii*, occurs (Williams, 1927) One local result of distension is that the capillaries of the intestinal mucosa become more permeable and some of their contents transude into the peritoneal cavity Here the water is absorbed by the peritoneum and a fluid, which becomes more and more like plasma in its protein content, is the result Thus loss of plasma from the circulation may be considerable—and loss of plasma decreases bowel motility, probably due to oedema of the bowel Thus a vicious circle is formed (Barden, Thompson, Ravdin, and Frank, 1938, O C Leigh, 1942)

Fluid is not only lost from the intestine, but since in most cases of paralytic ileus the pylorus also is inhibited or paralysed, vomiting of intestinal contents

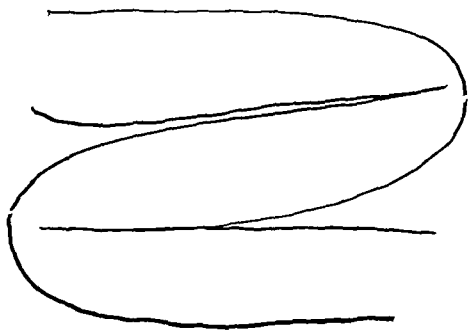


FIG 227—To show how obstruction occurs at each end of loops of small bowel in marked distension

occurs For instance, in *Case 1*, in which multiple ileal obstructions were present, fluid which could be recognized was introduced through the suction lumen of a Muller-Abbott tube, which had been radiologically proved to be in the mid-ileum, and was later vomited by the patient

The vomiting and loss of intestinal contents in turn bring about loss of sodium chloride Thus is started a deleterious vicious circle the loss of large amounts of the irreplaceable sodium ion causes a shrinkage in the blood-plasma volume, this loss leads to a diminution in the volume of intercellular fluid, and even if water is given by mouth, salts will be secreted into it, to be again lost in the vomitus The blood becomes hypotonic, the kidneys automatically correct this by excreting water and thus add to the dehydration Therefore, the haemo-concentration and dehydration caused, bring about a circulatory failure which primarily is attributable to the loss of sodium (Bockus, 1944)

One local effect of distension is that of itself it can cause further obstruction by the kinking of the distended small bowel at the apex of the loops (Ashcroft and Samuel, 1940, Ochsner, 1937) (Fig 227)

A further effect of distension is that the longitudinal and circular muscles are greatly weakened in their action by distension This is mechanical, and the pressure developed by the muscles decreases in proportion to the increase of the radius (R D Wright, 1946)

**General Effects**—There is a general effect from local distension Local distension of a loop of small bowel causes vomiting, anorexia, and inhibition of movement in the remainder (Youmans, 1944, Burget, Martzloff, Suckow, and Thornton, 1930) If the distended loop of bowel has been denervated, the distension causes no vomiting and no inhibition (Antonice and Lawson, 1941) In dogs, distension of an isolated loop of small bowel caused death in eight days, but the dogs could be kept alive longer by giving saline infusions

Patients with paralytic ileus have a great thirst because of their dehydration and loss of salt, and therefore much of the fluid found in the bowel has been taken by mouth

There is also a difference in the flow of bile The author has noticed that in most of his cases of paralytic ileus there was little or no sign of bile in the aspirated fluid This may have been due to extreme dilution of bile, or to the fact that distension of the intestine decreases the bile flow (Schnedorf and Orr, 1941) Here again is a vicious cycle, for bile administered either through the duodenum or injected into an isolated loop of intestine greatly increases its motility (Haney, Roley, and Cole, 1939)

It is characteristic of a fully developed paralytic ileus that the large intestine is also involved This has been shown by X-ray studies (Hunt, 1944), and also it was the experience of the author that in cases of fully developed paralytic ileus enemas were retained or returned without result This is illustrated in the following case—

**Example 12**—An interval appendicectomy was performed Thirty-six hours after the operation the patient began to suffer from severe colicky, central-abdominal pains, which were unrelieved by  $\frac{1}{2}$  gr morphine The colic occurred once every one to three minutes and lasted half a minute Severe distension quickly developed, and there was some difficulty with micturition At this stage (the 'second stage', referred to later) two enemas were given, the first glycerin and soapy water and the second milk and treacle Both enemas were of one to one-and-a-half pints, and both were retained Neither gave relief from the colic Next day the colic had ceased, but purgatives, including two doses of calomel, were given without results On the eighth day the bowels were opened with an enema and from that time on distension and discomfort were relieved This case is quoted to show that in incipient paralytic ileus the colon is involved and that enemas do not act or remove distension or relieve colicky pains

The pathology of paralytic ileus, arising as a result of infective or mechanical causes, will be associated with those pathological changes characteristic of inflammatory abdominal foci and of mechanical obstruction

## THE VARIOUS TREATMENTS OF PARALYTIC ILEUS

The methods of treatment recommended both for prophylaxis and in the developed disease have been many, varied, and confusing

The 'whippers-up' or 'stimulators' of the bowel form one school. Their treatment is based on the fact that in this condition the bowels do not open, and, therefore, if the bowels are opened the condition will be cured. However, the absolute constipation (lack of defaecation and passage of flatus) is only a symptom and not the disease. Stimulation of the bowel was formerly the method of treatment, and is only now going into disrepute as a general measure. Thus, Stout (1943) advised early parasympathetic stimulants as prophylactic treatment against paralytic ileus, e.g., 0.5 mg prostigmine, or 1 mg thiamine hydrochloride every four hours for ten doses as a prophylactic. Marden and Williamson (1939) recommended prostigmine methylsulphate, 1 c.c. of 1-4000 solution, as a prophylactic, and 1 c.c. of 1-2000 solution to combat fully developed paralytic ileus.

Ochsner, Gage, and Cutting (1930) concluded that physostigmine was the only drug which had a definite place in the treatment of intestinal atony. Hartman and Dock (1927), on the other hand, supported the use of choline.

Treatment by stimulation with cathartics increases the movement of the normal small bowel (Oppenheimer and Mann, 1941), but many personally observed cases show that during an established ileus they have no effect whatsoever.

The following cases illustrate the ineffectiveness of cathartics in paralytic ileus (if cathartics 'work', the patient has not got paralytic ileus) —

*Example 13* — A middle-aged woman had had a hysterectomy performed. On the second day she was given an enema without result, then cascara and paraffin and magnesium sulphate, without either results or abdominal colic. Next day more cascara and another enema were given, again without result. When seen on the fourth day she was very distended, and on auscultation of her abdomen occasional sounds were heard. She recovered after  $\frac{1}{2}$  gr morphine had been given four-hourly for three days. Her bowels were then opened by an enema.

(*Example 17* also illustrates the ineffectiveness of cathartics in ileus.)

Among the stimulant forms of treatment must be mentioned the giving of intravenous hypertonic saline solution as advocated by Ochsner, Gage, and Cutting (1933), as this had been shown to increase peristalsis (Hughson and Scarff, 1924; Kleitsch and Puestow, 1939).

Pitressin and pituitary extracts have been extensively given for ileus.

Yet another school favour the treatment of ileus by "resting of the bowel",  $\frac{1}{2}$  gr morphine given every four hours is said to "rest" the bowels. (See p 167)

Another treatment of ileus has been the use of spinal and splanchnic anaesthesia, which has been shown at least temporarily to increase peristalsis (David and Loring, 1930; Wagner, 1919; Novikov, 1939).

Ileostomy is not a physiological method of treatment of paralytic ileus, as it drains only the segments in which it is placed, yet a number of reports of the successful use of ileostomy are reported in the literature. But the bowel is not acting and therefore will not drive the contents down to the ileostomy opening, and also in a paralytic ileus the folding of the distended small bowel gives acute obstruction at the apex of each fold. (See Fig 227)

The difference between paralytic ileus and obstruction is clearly shown in the radiograph of the two conditions. In paralytic ileus small pockets of gas are seen scattered all over the abdomen and the colon is also distended, whereas in acute obstruction continuous loops of distended bowel are seen. Thus, when paralytic ileus is cured the ileostomy acts furiously and well, but it is not the ileostomy which has cured the conditions.

*Example 14* — Paralytic ileus followed the making of an ileostomy as a preliminary to colectomy. In this fully developed condition the patient would not tolerate the Miller-Abbott tube in the pharynx, so it was introduced through a jejunostomy under local anaesthesia. No peritonitis was found when this was being done. The abdomen was finally decompressed, but the patient died on the tenth post-operative day from a pulmonary embolus.

In several cases the ileostomy did not work until the balloon of the Miller-Abbott tube had issued from it.

The following case illustrates the ineffectiveness of an ileostomy in the treatment of paralytic ileus.

*Example 15* — A middle-aged and very obese man had had an acutely inflamed appendix removed. On the fourth post-operative day he began to get distended and to vomit copiously. A Miller-Abbott tube was successfully passed and drew off large quantities of fluid. However, the patient had a slightly elevated temperature and his general condition did not improve. The surgeon re-opened the wound, and, on not finding pus, did an ileostomy. On the seventh post-operative day the nursing sister reported a slough in the wound, which turned out to be the bag of the Miller-Abbott tube. The tube was then removed, and the ileostomy commenced to function well.

A further method of treatment of paralytic ileus which is much used is prolonged gastric or duodenal suction with continuous intravenous fluid administration (Wangensteen, 1942; Wangenstein, Rea, Smith, and Schwyzer, 1939; Penberthy, Noer, and Benson, 1940; Bartels, 1943, and many others).

Since most of the gas in the bowel has been shown to be swallowed air, this seems a very logical method of prophylaxis.

Finally, the last method of treatment of paralytic ileus is by use of the Miller-Abbott tube (Abbott and Miller, 1934; Ravdin and Abbott, 1940; Miller, 1944; R. A. Wise, 1938; Boon, 1940; Penberthy, Noer, and Benson, 1940; Lofstrom and Noer, 1940; Bennett, 1941; Kaplan and Michel, 1941; Noer and Johnston, 1942; Grimson and Hodge, 1944; Glen, 1941; Smith, 1945, and many others).

Ladd and Gross (1941) stress the value of a high oxygen concentration in a tent in cases of abdominal distension. Probably this helps to maintain the oxygen concentration in the lumen of the affected gut.

Thus there are three schools of treatment —

- 1 Stimulative, with enemas, drugs, and cathartics
- 2 'Resting' the bowel with morphine and perhaps heat on the abdomen, turpentine stupes, etc
- 3 The aspiration of stomach, duodenum, or the entire intestine

Each has its advocates. As a result of this clinical study of paralytic ileus, each treatment would seem to be correct at the right period of the disease, but not at another.

## II

A study of the treatment of post-operative ileus—and paralytic ileus—logically involves a consideration of the following —

- 1 Normal bowel movements
- 2 Those drugs and procedures which are used to increase movements
- 3 The action on the human small intestine of morphine—a drug frequently used in the treatment of ileus, not only for its action on the muscle of the small intestine, but also for the induction of sleep and relief of pain
- 4 Drugs which decrease the motor function of the small intestine and might therefore conduce to post-operative ileus
- 5 Drugs used in general treatment which might decrease intestinal movements and conduce to ileus
- 6 Coincident or coexisting pathological conditions which might pave the way to a post-operative ileus

### THE NORMAL MOVEMENTS OF THE SMALL INTESTINE

It is necessary fully to understand the normal movements of the small intestine if the treatment of their absence is to be undertaken.

There is an inherent rhythm of bowel muscle even when isolated from a nerve-supply (Thomas and Kuntz, 1926). However, the nerve-supply co-ordinates peristalsis in response to local stimuli and the central nervous system in turn superimposes its control on the reflexes, as exemplified by a book-loving professor who complained of turbulent borborygmi on entering second-hand bookshops.

The irritability and amount of small-bowel movement decreases from above downwards in a gradient (Alvarez, 1928). Small-bowel movements fundamentally consist of rhythmic 'feeler' waves which establish the presence of resistance to contraction (an adequate stimulus as shown by the fact that resistance to contraction can cause pain), and once the presence of the intestinal contents is so determined, a peristaltic wave follows. Bowel movements still occur in denervated bowel (Bayliss and Starling, 1899).

Bowel movements as recorded on a Miller-Abbott tube balloon are irregular and of three main types. The first type occurs five to ten times a minute and is small in amplitude. The second type has the first type superimposed on it and consists of an alteration in tone occurring two or three times a minute. The third type is a big alteration in tone with both the first and the second waves superimposed on it, occurring once every one to three

minutes. Personal experience has shown that the presence of the balloon of the Miller-Abbott tube low down in the ileum can be recognized by the type of recording obtained. Frequent type three waves are found in the upper ileum and jejunum where, when the tube is well down in the ileum, types one and two waves are not so marked, and powerful infrequent type three waves are noted (Hudobro, Montero, and Cuevas, 1944; Abbott and Pendergrass, 1936; Forster, 1940)\*.

### DRUGS WHICH ARE USED TO INCREASE THE MOVEMENTS OF THE HUMAN SMALL INTESTINE

As has been pointed out above, one routine treatment of established ileus is the use of drugs which stimulate the movements and increase the motility of the small intestine. The action and use of some of these drugs is described.

*Confusion in regard to the Action on the Muscle of the Human Intestine of Drugs and Procedures*—In the literature there exists much doubt in regard to the action of drugs on the human intestine. This is owing to the fact that the effect of drugs or solutions has been tried on isolated intestine, or in animals in which either X-ray, intestinal balloon, or exteriorized loops have been used, or in human beings where X-ray, balloons, or systems of balloons introduced from above through the stomach or from below through an ileostomy have been connected to recording apparatus, or to the fact that observations of various types have been made on exteriorized loops of bowel, or that observations have been made on the abdomen while open at operation. But despite the fact that, for the reasons given above, there is much difference of opinion in regard to the effect of drugs on the movement of the small bowel of animals and man, the action of certain of these drugs seems to be well accepted and to be clear.

**Prostigmine**—Stout (1943) advises early use of parasympathetic stimulants as prophylactic treatment against paralytic ileus. He advises 0.5 mg prostigmine methylsulphate and 1 mg thiamine hydrochloride every four hours for ten doses as a prophylactic. Marden and Williamson (1939) recommend prostigmine methylsulphate, 1 c.c. of 1-4000 solution as a prophylactic and 1 c.c. of 1-2000 solution to combat developed paralytic ileus.

Ochsner, Gage, and Cutting (1930) are of opinion that physostigmine is the only stimulative drug which has a definite place in the treatment of intestinal atony.

**Acetylcholine**—Hartman and Dock (1927) favour the use of choline. Feldberg and Solandt (1942) used isolated rabbits' intestines and found that acetylcholine caused immediate shortening of the isolated gut, but that glucose was necessary for continuance of this excitability of the longitudinal muscles to the drug. Small doses of atropine abolished the stimulating effect of acetylcholine.

\* In a case in which there was prolapse of 3 in. of ileum through an ileostomy, repeated observations showed that the papilla contracted and described rhythmic sigmoid curves indistinguishable from those ascribed to the 'ileocaecal valve'.



Ochsner, Gage, and Cutting (1930) found little effect from acetylcholine on peristalsis in dogs

**Pituitary Extracts, Pitressin, Pituitrin**—Puestow (1942) found that, following the administration of pituitary extract, there was a contrary motility between the small and the large bowel, that when the small bowel was vigorously contracting the colon was inactive, and vice versa. He showed that posterior pituitary extract and pitressin produced powerful contractions of the colon, but diminished motility of the small bowel. Carlson (1930) found that 1 c.c. of pituitary extract in a patient with an ileostomy gave increased peristalsis with issue of gas and faeces. In dogs the result was not so constant. Burge (1944), who studied the ileocaecal valve in a patient in which it had prolapsed, found that 1 c.c. of posterior pituitary extract increased propulsive and non-propulsive (or mixing) movements in this region and caused gas pains. It produced a segmental contraction of one segment, which was relieved by amyl nitrite.

Pituitary extract and pitressin regularly increased colon motility (Carlson, 1930, Puestow, 1942, Burge, 1944). Radiologists take advantage of pitressin to rid the bowel of gas shadows, when taking radiographs of the renal tract (Kenning and Lofstrom, 1937). On the isolated small intestine, however, results are more equivocal.

Using isolated dogs' intestines, Gruber and Pipkin (1930) found that high dilutions of pituitary extracts caused an increased tonus, and tonic oscillation in duodenal and ileal strips, whereas high concentrations of the same drug caused loss of muscle tone and disappearance of the rhythmic (or mixing) movements. Huidobro, Montero, and Cuevas (1944) found in normal subjects with a Miller-Abbott tube in position that pitressin increased the spontaneous motility of the small bowel.

Ochsner, Gage, and Cutting (1930) tested the action of pituitary extracts in a series of twenty-nine dogs. They found characteristically a decrease in tone and inhibition of peristaltic movement, and in only two cases an increase in tone. They were of opinion that pituitary extract was not only ineffective, but dangerous, in intestinal atony.

The author made observations on the small bowel with the Miller-Abbott tube in position. In the case reported below the contractions of the small intestine, which up to the time of injection of pituitrin had been painless, became painful and increased.

*Example 16*—A man, aged 21 years, had an appendectomy performed. Three weeks later he began to get colicky abdominal pains and occasional vomiting. A Miller-Abbott tube was passed and relieved his pain and vomiting. He began to eat. Again, one week after the removal of the tube, he began to vomit and to become distended. At this stage he had visible peristalsis. A Miller-Abbott tube was again passed. A second operation was performed and many adhesions caused by plastic peritonitis were divided. During his recovery the Miller-Abbott tube, which was in position, was connected to a recording tambour. While it was in the lower ileum, doses of pituitrin of 1 c.c. were given on two occasions. Within twenty minutes of the giving of the intramuscular injection the patient complained of colicky central abdominal pains which coincided with increased peristaltic waves as shown on the recording tambour. Luminal,

in 1-gr doses, decreased the peristaltic activity for some hours.

These diverse experimental findings in human beings and animals may perhaps be reconciled thus. If the colon is intact and pituitrin stimulates the motility, then it may later increase the small-bowel motility by a reflex. (See later.)

**Cathartics**—Stimulant treatment with cathartics increases the movements of the normal small bowel (Oppenheimer and Mann, 1941).

*Castor oil* causes increased amplitude and rate of peristalsis in exteriorized loops of bowel in dogs. *Magnesium sulphate* does not increase the rate of movements or tone of the small bowel, it has only a mechanical action. *Cascara* does not change the rate of movement, but occasionally increases the response to local stimulus.

In established paralytic ileus cathartics have no effect whatever. If cathartics 'work', the patient has not got paralytic ileus. This case of paralytic ileus—one of many—demonstrates it.

*Example 17*—A middle-aged woman had had a hysterectomy performed. On the second day she was given an enema without result, then cascara and paraffin and magnesium sulphate without either getting a result or causing colicky pains. Next day more cascara and another enema were given, again without result. When seen on the fourth day she was very distended, and on auscultation of her abdomen occasional sounds were heard. She recovered after  $\frac{1}{2}$  gr morphine had been given four-hourly for three days. Her bowels then opened with an enema.

Therefore, though cathartics may at times slightly increase the movements of the small bowel for a short while, they should have no place in pre- and immediate post-operative treatment of patients undergoing surgical operations. Their use before operation is followed by a period in which there is less bowel motility and a decreased response to local stimulants. Furthermore, cathartics irritate the bowel, increase the fluid contents of the bowel, and prevent absorption of nutritive material from it. Following purgation, the bowel does not react well to drugs, and there is an increased growth of bacteria within its lumen, and if continued there is increased gas and fluid in the lumen, a condition predisposing to the development of paralytic ileus (Alvarez, 1918, and Alvarez and Taylor, 1917-18).

**Apomorphine**—According to experiments on dogs, apomorphine causes peristaltic waves in the small intestine associated with attempts to vomit, which are followed by a decrease in the height of the contractions and in muscle tone, lasting from twenty to sixty minutes (Slaughter and Gross, 1938).

**Vitamins**—Crandell, Chesley, Hansen, and Dunbar (1939) found that, following the giving of thiamine and riboflavin and nicotinic acid to dogs and human beings with functional digestive disorders, some cases exhibited an intestinal hyper-motility.

It is the author's experience that the use of vitamin B complex has been most effective as a help in dealing with habitual constipation, but it has also been noticed on numerous occasions that patients to whom these drugs have been given are conscious of painful intestinal motility (umbilical pain) while they are taking them.



Some patients who have been given ascorbic acid also complain of colicky abdominal pains. This also may be due to hypermotility, for Haag and Taliaferro (1940) found that, at least in the colon (isolated from a guinea-pig), ascorbic acid caused greatly increased tone.

**Bran**—No change in the movements or evacuation of the small intestine was found by Fantus, Kopstein, and Schmidt (1940) and Streicher and Quirk (1943) in making X-ray studies of bowel motility in the normal individual.

**Bile and Bile-salts**—Haney, Roley, and Cole (1939) found that bile or bile-salts increased the rate of propulsion through isolated loops of dogs' intestines, hence the importance of giving bile-salts in paralytic ileus.

**Hypertonic Saline into Bowel Lumen**—Bayliss and Starling (1899) mention that hypertonic saline solutions injected into the lumen of the gut are followed by very vigorous peristalsis.

### PROCEDURES WHICH ARE USED TO STIMULATE THE MOVEMENTS OF THE SMALL INTESTINE

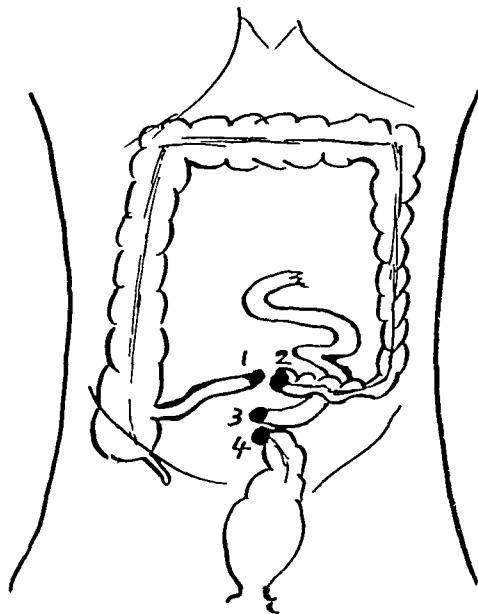
**Intravenous Hypertonic Salt Solution**—Among the stimulant forms of treatment must be mentioned the intravenous infusion of hypertonic saline solution as advocated by Ochsner, Gage, and Cutting (1933). From 15 to 20 c.c. of 20 per cent sodium chloride solution, injected intravenously, has been found to increase small-bowel motility (Ochsner, Gage, and Cutting, 1930; Kleitch and Puestow, 1939; Hughson and Scarff, 1924; Quigley, Highstone, and Ivy, 1934). Kleitch and Puestow (1939) found that physiological saline given intravenously for twenty minutes gave a sustained rise in the frequency of contraction and also in the secretion of the small intestine of dogs. Dextrose solution (10 per cent) did not give much change, but physiological saline with 10 per cent dextrose in it definitely increased motility. They found that insulin decreased the motility. Their observation confirms that of Feldberg and Solandt (1942) that the action of nicotine on the intestine depends on the presence of glucose in adequate supply.

**Spinal and Splanchnic Anaesthesia**—There is little doubt that where small-bowel motility is arrested or diminished, spinal and splanchnic anaesthesia causes an increase, at any rate, during the time the anaesthesia is active (Wagner, 1919; David and Loring, 1930; and Novikov, 1940). When spinal anaesthesia was used on patients who had morphine as a pre-operative treatment, little effect on the motility of the small intestine from spinal anaesthesia was found by Helm and Ingelfinger (1944). The following case illustrates this—

**Example 18**—A woman had an acute obstruction of the small intestine. A Miller-Abbott tube was passed for the two hours during which she was being prepared for the theatre. At operation the tip of the tube was found to be in the intestine about 2 ft. from the pylorus. Before operation little or no motility could be observed on the balloon. As soon as the spinal anaesthetic was given, waves of motility were recorded on the tambour, and at operation they were seen.

**Food by Mouth**—The gastro-ileal reflex is physiologically well known. It can be observed on any patient with an ileostomy. Following the taking of food, the ileostomy acts with increased vigour.

**Colonic Enemas and Wash-outs**—Repeated observations on a man who had an acting ileostomy at the same time as he had a colon isolated from the faecal stream as a preliminary to its removal (*Fig 228* shows this arrangement) showed that whenever



**FIG 228**—To show the arrangement of loops of bowel as a preliminary to subtotal colectomy for ulcerative colitis, the ileum being eventually joined to the rectum by clamp 1, End of functioning ileum, 2, End of functioning colon, 3, Functioning ileostomy, 4, Cut end of rectum.

either the colon or the rectum was washed out, or an enema given, within five or ten minutes there was a most vigorous action of the ileostomy. At times this action was so vigorous that jets of chyme were shot several feet into the air.

These observations were repeated and confirmed on a woman who also had an isolated colon as a preliminary to colectomy (*Fig 229*).

Thus enemas and bowel wash-outs must be regarded as the most effective stimulative treatment to a small bowel capable of response.

**Heat to the Abdomen**—This time-honoured method of treating paralytic ileus, which is supposed to increase the motor function of the bowel, and particularly the pendulum movement, was found to have no effect. In three patients in whom heat was applied to the abdomen while the recording Miller-Abbott tube was in position, no change in the motility of the intestine was observed.

**Example 19**—This patient had a tube in position following operation for division of adhesions which were causing intestinal obstruction with visible peristalsis. On two occasions a radiant heat cradle was put on the naked abdomen for periods of from half an hour to one and a half hours without altering the character or strength or frequency of the bowel movement as recorded on the Miller-Abbott tambour.

**Example 20**—The patient had a Miller-Abbott tube both before and after an operation for division of multiple adhesions of the small bowel. On two occasions hot bottles applied to the abdomen did not in any way alter the character or frequency of intestinal contractions.

**Example 21**—A young woman had an ileostomy as a preliminary to colectomy. A balloon was introduced into the ileostomy for about 4 in. Heat was applied to the abdomen by hot-water bottles for twenty minutes, and also a turpentine stupe at the same time, without effecting the bowel motility (see Fig 229).

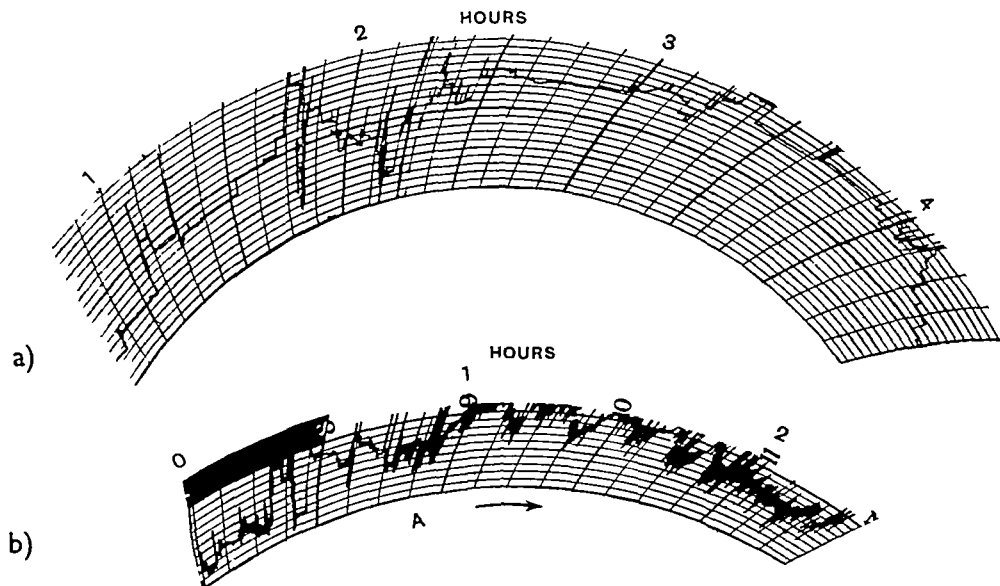


FIG 229—*Example 42* a, A record of four and three-quarter hours taken immediately after operation when little or no bowel movement was present, showing variations in the record produced by coughing, vomiting, gasping etc. b, A record for two and a half hours showing the development of movements 10 hours after introduction of the tube through jejunostomy. First movements shown in Fig 238. From the mark A the record is typical of fairly normal jejunal movements. (Cf Fig 234, where the movements of the one-and-three-quarter-hour period to the mark C are typical of normal lower ileal movements.)

It has also been found by McLoughlin, Mann, and Krusen (1941) that short-wave diathermy does not affect intestinal motility.

**Turpentine Stupes on the Abdomen**—This also time-honoured treatment was used in *Example 21* mentioned above, with no effect either clinically or on the bowel movement as shown by the recording tambour (Fig 229).

### THE ACTION OF MORPHINE ON THE HUMAN SMALL INTESTINE

With regard to the effect of morphine on the human small intestine, some confusion exists because, as has been pointed out, workers have sought information in this respect in so many different ways. Thus, if the morphine method of treating ileus is to be intelligently carried out, its mode of action must be studied and, if possible, clarified.

Using isolated strips of intestine, Gruber and Pipkin (1930) found that morphine increased the tonus and in some cases the height of rhythmic contraction of the muscle.

Using experimental animals, Kanan (1937) placed balloons in Thiery-Vella loops in the ileum and measured propulsive motility, and found that morphine sulphate increased propulsion for from

twenty to forty minutes after the injection, but for some hours later the rate of propulsion was slower than normal. Atropine was found to counteract the effect of the morphine.

Using similar preparations Gruber, Greene, Drayer, and Crawford (1930) found a rise of tone following injections of morphine.

Determining by X rays the rate of propulsion in Thiery-Vella loops in dogs, Qugley, Highstone, and Ivy (1934) found, as the result of morphine injection, an increased rate of propulsion in the

ileum lasting for forty minutes, then a decrease for some hours. In the loops of the duodenum the initial increase of propulsive activity was greater than in the ileum.

Plant and Miller (1926), using non-anæsthetized dogs, also found an immediate increase of frequency in the amplitude of peristaltic waves, but, when this passed off, the tone still remained above normal.

The following observations on man when contrasted with that of the animal intestine show some discrepancies—

Plant and Miller (1926) took tracings from the ileum of a man with an ileostomy and found that  $\frac{1}{2}$  gr morphine increased the number of waves and the tone, but decreased the amplitude of peristaltic waves. They saw similar changes in two men with thin-walled herniæ when, after the giving of  $\frac{1}{2}$  gr morphine hypodermically, contractions were noted and an increase of the frequency of waves passing over the bowel was perceived. The appearance did not return to normal for one and a half hours after injection of morphine. They found similar effects by using heroin and codeine.

Forster (1940) studied movements of the circular and longitudinal muscles separately by means of recording instruments attached by stitches to the

exteriorized ileum in man. He found that  $\frac{1}{8}$  gr morphine increased the frequency of the mixing waves and the peristaltic waves, and that a second injection of  $\frac{1}{8}$  gr twenty to thirty minutes later decreased the frequency of the mixing waves or pendulum movements, but increased the tone of both muscle coats.

Hudobro, Montero, and Cuevas (1944), recording from the balloon of the Miller-Abbott tube in normal subjects, found that morphine decreased the motor activities in the duodenum and ileum. In large doses it caused movement to disappear with slightly increased tonus.

Abbott and Pendergrass (1936), using a Miller-Abbott tube, found that morphine produced stimulation in the upper part of the small bowel for a short period, followed by depression, but there might be no change at all in the motility of the ileum. There was duodenal spasm for two minutes following the injection and then relaxation lasting up to three hours. Barium conglomerated in the ileum and filled loops, giving the appearance of a string of sausages. Disordered and non-propulsive movements persisted for three hours after injection. The effects of morphine on the gastro-intestinal tract lasted for up to three days, the ileum emptying more slowly for twenty-four hours.

Plant and Miller (1926) state that the primary effect of morphine on the small intestine is stimulation of muscular activity and tone, while contractions remained unaltered or even slightly decreased.

Myers and Davidson (1938), reviewing the literature, came to the conclusion that the constipation of morphine was due to pyloric obstruction and consequent delay of stomach emptying.

Puestow (1942) states that morphine constantly stimulates the small bowel, but by inhibiting colonic contraction may be a factor in causing post-operative distension due to gas distension.

The author studied three cases in which tracings and observations were made on patients with the Miller-Abbott tube and recording tambour. In these cases no gross difference could be observed in the contractions after  $\frac{1}{8}$  gr morphine had been given intramuscularly. But in one case, on five occasions when a balloon was introduced through an ileostomy (Fig 230) tone was increased, mixing movements were more frequent, and peristaltic movements were decreased.

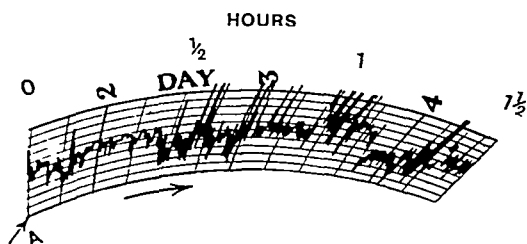


FIG 230—Example 42. To show the effect on bowel motility of an injection of  $\frac{1}{8}$  gr morphine given at A.

The treatment of paralytic ileus by injections of morphine has therefore a sound physiological basis, not because it rests the bowel but because it increases the number of small mixing waves and raises the

muscle tone. Both these actions tend to prevent the onset of an 'irreversible' stage of ileus. This latter is the stage of ileus which occurs when distension has increased to such intensity that (a) it presses on the veins and so causes a vicious circle in which decreased gas absorption resulting from the venous pressure leads to more distension and thus further venous pressure (Dragstedt, Lang, and Millett in 1929 showed that distension interfered most with blood-supply in the duodenum and least in the large bowel), and (b) it causes of itself an actual mechanical obstruction by a kinking of the ends of the loops (see Figs 226, 227).

Treatment with morphine will prevent this intensity of distension and therefore facilitates the absorption of gas by increasing the muscle tone and by increasing the number of small mixing waves.

To sum up, the results of the investigation of morphine seem to show that there is agreement that morphine (1) delays the passage of food through the intestine and therefore causes constipation, (2) causes duodenal spasms for a short while, followed by relaxation, (3) decreases peristaltic movement of the duodenum and ileum, but increases (a) the tone, and (b) the frequency, of the small mixing waves.

## DRUGS WHICH DECREASE THE MOTOR ACTIVITY OF THE HUMAN SMALL INTESTINE

Drugs which depress the motor activity of the human small intestine have a bearing on the treatment of ileus, for their use in post-operative treatment may have an influence in the production of post-operative paralytic ileus.

**Atropine**—Atropine given in normal doses causes inhibition of contraction and loss of tone of the small bowel (Forster, 1940, Hudobro, Montero, and Cuevas, 1944, Gruber, Greene, Drayer, and Crawford, 1930, Kanan, 1937).

**Trasentin** causes a decrease in small-bowel movement, especially when given through the Miller-Abbott tube. Local anaesthetics given through a Miller-Abbott tube also decrease the bowel movement (Crohn, Olson, and Necheles, 1944).

In only one of three cases was trasentin effective in relieving spasms caused by intestinal colic resulting from adhesions due to plastic peritonitis.

The author found no effect by giving trasentin by mouth in a case of chronic small-bowel obstruction when the Miller tube had been passed pre-operatively and the balloon was in the lower ileum.

**Hyoscine** has an action similar to, but weaker than, atropine (Gruber, Greene, Drayer, and Crawford, 1930).

**Adrenaline and Neosynephrin** slow the contractions and decrease the tone of the intestine in dogs (Youmans, Aumann, and Haney, 1939).

**Amyl Nitrite** decreases both intestinal movement and tone. In the following case the effect of amyl nitrite on intestinal movement is seen.

**Example 22**—A patient came into hospital with intestinal obstruction. She had had nine previous operations for adhesions and obstruction following a hysterectomy operation. Before being operated upon there was visible peristalsis in the abdomen and colicky pains, both of

which were abolished by the giving of amyl nitrite. A Miller-Abbott tube was passed before operation, which emptied her intestine and stopped her pain. At operation the collapsed bowel and the site of obstruction, threaded on the Miller-Abbott tube, were easily found.

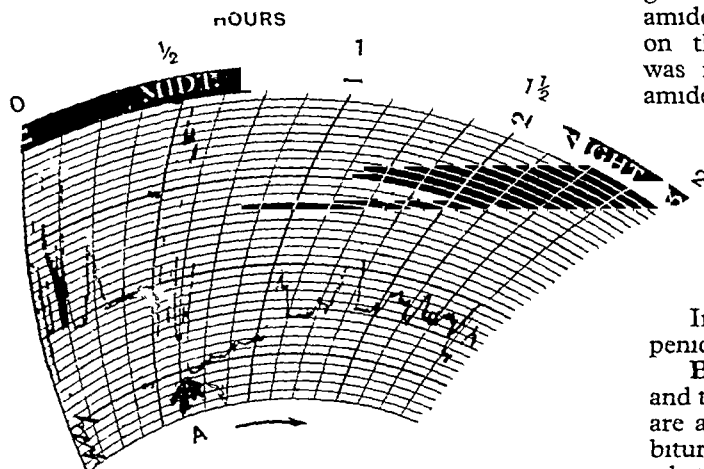


FIG 231—Example 25 To show the effect on bowel motility of 2½ gr of sodium luminal given intravenously at A. This dose was enough to make the patient feel sleepy, but not to put him to sleep without morphine given later.

Huidobro, Montero, and Cuevas (1944) also report decreased intestinal movement and tone after the use of amyl nitrite.

**Sulphonamides**—The author has studied the action of sulphonamides on the human intestine in a number of cases. He has found no appreciable difference in small-bowel motility when sulphonamides are given.

every four hours for four days. All this time she had a Miller-Abbott tube in her ileum and strong peristaltic contractions continued.

Pick, Brooks, and Unna (1944) found that in guinea-pigs with isolated intestinal loops sulphonamides inhibited the contracting effect of nicotine on the isolated intestine. Sodium sulphadiazine was not so effective as sulphathiazole, sulphamylamide, or sulphamerazine.

### DRUGS FREELY USED IN THE GENERAL TREATMENT OF ILEUS WHICH MAY DECREASE INTESTINAL MOVEMENTS AND CONDUCE TO A POST-OPERATIVE ILEUS

In this category are the barbiturates, aspirin, and penicillin.

**Barbiturates**—Work by Professor R. D. Wright and the fact that epileptic patients on luminal therapy are always constipated suggested an inquiry if barbiturates affect intestinal movements, and if so whether they might produce post-operative ileus.

Barbiturates were given to three patients in whom the Miller-Abbott balloon with an attached tambour was in the small intestine. Two-grain doses of luminal, given each night, caused a significant decrease in the amplitude of contraction for five or six hours. Subsequently no marked difference in muscle tone could be detected.

*Example 24*—In this patient a balloon was introduced through an ileostomy. A 3-gr dose of seconal was given and within half an hour the tambour recorded an increase of tone, and then almost complete cessant on



FIG 232—Radiograph four hours after taking barium by mouth.



FIG 233—Radiograph after the taking of barium and 1 gr of luminal. The colon is still full from the day before.

The following is an example from a number of cases observed—

*Example 23*—A woman developed paralytic ileus, with a high temperature, following a gynaecological operation. She was given sulphadiazine, 4 g immediately and 1 g

*Example 25*—In this case an ileostomy had been performed as a preliminary to removal of the colon. A post-operative ileus ensued. A Miller-Abbott tube had been introduced through a jejunostomy because the patient persistently pulled it out of his nose. On four occasions injections of 2½ gr of sodium luminal were

given intravenously, this was enough to make him sleepy. The tambour recorded a depression of motility which lasted several hours (Fig 231).

An X-ray study of the effect of luminal on bowel movement was undertaken on a middle-aged volunteer.

**Example 26**—Observations were made under identical conditions at the same time of the day, viz, four hours after the giving of four tablespoonfuls of barium by mouth. In the control experiment the tail of the barium column at the end of four hours was 6 in. from the ileo-cæcal junction. When 1 gr. of luminal was given to the same subject under the same conditions, the subject complained of much sleepiness, and the tail of the barium column was at least 2 ft. and possibly 3 ft., from the ileo-cæcal junction (Figs 232, 233).

There was thus a retardation of the flow of barium through the small intestine following the administration of the luminal.

Using isolated intestine of rats or rabbits, Shaw (1942) found that luminal, dial, seconal, etc., caused a decrease in tone and sometimes a cessation of motility.

Florey, Wright, and Jennings (1941) noticed that the secretion of mucus in the colon was decreased by barbiturates.

It would appear, therefore, that barbiturates should be given with caution in cases in which there is

movement. In a woman of 35 years who had an ileostomy for ulcerative colitis, 10 gr. of aspirin abolished the larger occasional 'peristaltic' movements of the



FIG 235—Radiograph four hours after barium by mouth plus 15 gr. of aspirin, under the same conditions as Fig 234.

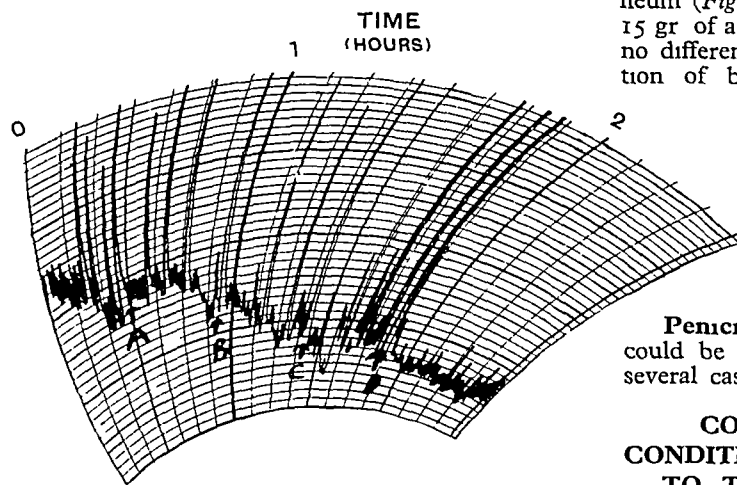


FIG 234—To show the effect of turpentine stipes (B) (applied for twenty minutes), heat to the abdomen (A) (applied for twenty minutes), the wash out (with half a pint of saline) of the disconnected rectum in which the rectum was joined to the ileum (C) and of 10 gr. of aspirin (D), on bowel movements as recorded from a balloon introduced through a prolapsing ileostomy from the disconnected terminal ileum (The ileum, as connected to the rectum as a preliminary for colectomy and the distal disconnected ileum and sigmoid colon were brought out on to the abdominal surface).

a possibility of paralytic ileus. They certainly should not be given in cases of established paralytic ileus as they decrease peristalsis and tone, and consequently as a result of the increased distension, might just change a developed paralytic ileus which is in a 'reversible' stage into one which is 'irreversible'.

**Aspirin**—In a middle-aged woman with a recording Miller-Abbott tube in position, who had had a resection for a carcinoma of the ileum, 10 gr. of aspirin almost caused cessation of ileal

ileum (Fig 234). In a normal middle-aged subject, 15 gr. of aspirin (given with barium emulsion) made no difference, compared with a control administration of barium without aspirin under identical conditions (Fig 235). The dose of aspirin, 15 gr., was enough to make the patient "sleepy".

It thus appears that the rate of propulsion of the content of the small bowel is not materially altered by aspirin—though occasionally decrease of intestinal movement followed its exhibition.

**Penicillin**—No effect on intestinal movement could be found with large doses of penicillin in several cases.

### COINCIDENT PATHOLOGICAL CONDITIONS WHICH MAY CONTRIBUTE TO THE OCCURRENCE OF POST-OPERATIVE PARALYTIC ILEUS

**Hypoproteinaemia**—In two patients with a Miller-Abbott tube in position, the author was able to record definite increase in small-bowel motility following serum transfusions. Their case records are as follows—

**Example 27**—A Miller-Abbott tube had been introduced for a post-operative ileus. No progress was made after it was 4 or 5 in. past the pylorus. Two pints of serum were given. Movements increased in amplitude and frequency, and the tube began to move and fluid was aspirated.

**Example 28**—A woman who had had many previous operations for intestinal obstruction had a Miller-Abbott tube passed prior to operation. At operation it was found to be proximal to the obstructed segment of bowel. Twenty-four hours after operation occasional movements

of the bowel were being observed. Following the administration of a pint of intravenous serum, these quickly increased in frequency and amplitude.

That hypoproteinaemia is a potent cause of depression of small-bowel motility has been reported by Barden, Thompson, Ravdin, and Frank, 1938, Leigh, 1942, John Devine, 1938, Ravdin, Stengel, and Prushankin, 1940.

recommences when the packing is removed (See *Example 3*).

The cessation of bowel movement resulting from intraperitoneal irritation does not occur if the splanchnic nerves are cut, as they are part of the reflex arc through which inhibition of bowel movement occurs (Douglass and Mann, 1941), and the interference with this arc is the rationale for

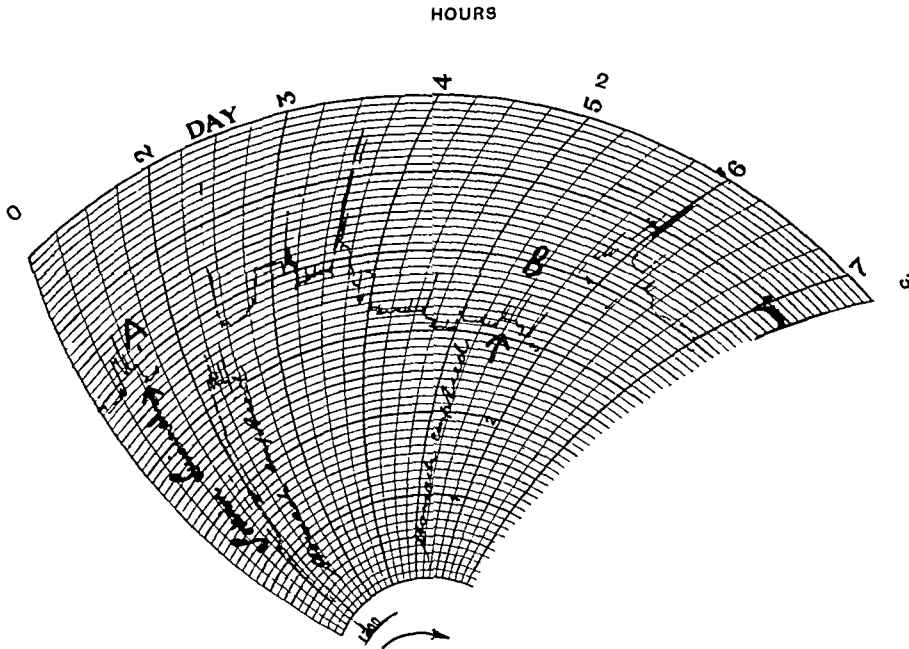


FIG 236—*Example 42*. To show the momentary complete loss of tone after giving 2½ gr of luminal intravenously at A, a dose which did not render the patient unconscious. It also illustrates the depression of peristalsis and tone resultant upon overdistension of the stomach and the effect of relief of this by removal of 100 oz of fluid through a stomach tube at B.

**Distension of the Upper Part of the Urinary Tract or of the Bladder**—In cases of urinary tract irritation, Allen and Jamison (1940) found increased bowel distension, indicating a degree of ileus, and confirmed by radiography.

Svien and Mann (1943) showed that distension of the urinary bladder caused inhibition of movements of the lower ileum, but distension of the upper urinary tract caused ileus of the whole of the small intestine.

It would appear that the type of patient who has urinary retention following operation has also a tendency to ileus. On the basis that distension of the bladder or pelvis of the kidney causes ileus, it is suggested that unrelieved post-operative retention of urine might contribute to or even be the origin of paralytic ileus—this is an important practical point in post-operative treatment.

**Intraperitoneal Procedures** Intraperitoneal Irritation—Intraperitoneal procedures or intraperitoneal irritants cause prolonged arrest of small-bowel movement (Douglass and Mann, 1941, Wakim and Mann, 1943).

Arrest of small-bowel movement for a varying period results from intraperitoneal procedures after every abdominal operation, whether a general or local anaesthetic is used, e.g., packing introduced into the abdominal cavity may cause prolonged cessation of small-bowel movement which will only

using splanchnic or spinal anaesthesia in the treatment of 'true' paralytic ileus.

**Over-distension of the Stomach**—The author has found that over-distension of the stomach inhibits intestinal movement.

This observation was made possible because jejunostomies had to be done on two desperate cases of paralytic ileus, too ill and unco-operative for the tube to be passed by mouth. Both had a recording Miller-Abbott tube passed into the ileum through the jejunostomy. In each case the stomach and upper part of the jejunum, unrelieved by the Miller-Abbott tube, remained greatly distended. In each case the tambour recording movements of the small intestine occasionally showed a complete absence of peristalsis. And in both of these cases, following aspiration of varying amounts of brownish fluid up to 100 ounces through a separate Rehffuss tube introduced through the mouth into the stomach, the result was that the tambour recorded the return of peristalsis.

The details of these cases are as follows—

*Example 29*—A young woman had had a paralytic ileus following a gynaecological operation. This in turn was followed by peritonitis, and finally, a fortnight after the operation, by organic small-bowel obstruction. After the Miller-Abbott tube had been passed twice by mouth, it could not be passed on a third occasion. It was then passed through a jejunostomy made under local

anæsthesia Eight hours afterwards the first small-bowel movements were recorded. On several occasions peristalsis was observed to stop, and on each occasion aspiration of the stomach drew off a large quantity of fluid, and within half an hour peristaltic movements returned.

*Example 30*—The Miller-Abbott tube was in the ileum, having been introduced through a jejunostomy, and cessation of peristalsis was on several occasions associated with epigastric fullness. A stomach tube was then used to draw off up to 128 oz of fluid. Immediately peristalsis recommenced (*Figs 227, 236*). This was repeated on at least five occasions.

This reflex, resulting from gastric distension, is physiologically reasonable, since distension of an isolated loop of small bowel and of the urinary bladder has already been shown to cause inhibition of small-bowel peristalsis, and therefore it is important to prevent over-distension of the stomach following operations, and to anticipate any tendency to acute gastric dilatation by promptly emptying the stomach by a Rehfuß tube before inhibition of intestinal movements can occur.\*

### III

#### THE DEVELOPMENT OF A CONCEPT OF PARALYTIC ILEUS

In a fully developed paralytic ileus auscultation of the abdomen reveals no sounds and a recording tambour in the intestine shows no movements.

In this clinical study it was found that in a person in good health intestinal sounds (*borborygmi*) were always heard in the abdomen. They were usually most pronounced after a meal, and had a certain regularity. Abdominal auscultation made on a number of patients following routine operations, showed that the first sounds were heard between four and eight hours after the operation. It also disclosed the interesting fact that the first sounds are irregular, turbulent, and often accompanied by pain, at first they were infrequent and later become almost continuous, quite unlike those heard in the normal abdomen.

The cause of these first sounds following operation was investigated by the use of the Miller-Abbott tube with recording tambour, as is seen in the following case.

*Example 31*—A middle-aged woman had had nine previous operations for intestinal obstruction caused by a constant recurrence of adhesions which originated as a sequel of a hysterectomy. An acute supervening obstruction with distension and visible peristalsis made a tenth operation necessary. The Miller-Abbott tube was passed and relieved the distension and made the subsequent operation technically easy as no distended bowel was encountered, but the tip of the tube was found proximal to the area of obstruction. The bowel was dissected free and wrapped in omentum. Following the operation no movement occurred for eight hours. The recording tambour on the Miller-Abbott tube balloon then began to show several movements at intervals of half to one hour—each movement being accompanied by colicky central abdominal pain. These powerful, but occasional,

contractions then changed in about twenty hours to frequent irregular contractions, and after a further twelve hours the peristalsis recorded was indistinguishable from normal.

From these observations it would appear that, at the commencement of intestinal movements, after the normal period of 'physiological' or 'active' ileus following the opening of the abdominal cavity, there is a stage when there is no movement, then one when there is occasional irregular movement, later a stage in which there is more frequent but disordered movements, until finally the bowel recovers and its movements become ordered and normal.

After operations patients usually complain of 'gas pains'. Normal peristalsis is painless, therefore the cause of these pains must be some abnormality in internal movement. And the most likely one, judging from abdominal auscultations which the author has carried out and also from the tambour records, is inco-ordination.

If pain is caused by peristaltic contraction, then the only conceivable cause is that the bowel content cannot escape into the next segment, because of lack of the usual co-ordination, namely, contraction above followed by relaxation below. Wangenstein (1942) thinks that gas pains are the result of contraction of dilated loops on to their contents.

The author found clinically that, given in the first stage, when no movements can be heard, enemas are quite ineffective. They do neither good nor harm—they cause the patient no pain, being either retained or returned without force.

He found that in the second stage, or 'stage of disordered movement', stimulation by enemas, pituitrin, pitressin, eserine, or by other measures causes more distension and increased pain and discomfort for the patient. There is usually some passage of flatus, with little faecal result. In other words, it would appear that the stimulation caused painful bowel movements. Since normal peristalsis is painless, it is reasonable to assume that the pain was a result of abnormal peristalsis. It is also reasonable to assume further, that, since abnormal peristalsis is disordered and inco-ordinated movement, stimulation by giving pituitrin or enemas increases small-bowel movement without changing the character of the peristalsis present in this second stage. Thus, stimulation in this stage may increase the paralytic ileus. That this assumption is correct is shown by the fact that ileostomy wash-outs given in this second stage to two patients caused 'gas pains' almost immediately, with increased distension.

The following case record shows how stimulation can turn a condition of ileus into one of paralytic ileus—

*Example 32*—A middle-aged woman had an operation for band obstruction of the small intestine, which occurred as a complication of a resection of a volvulus of the sigmoid colon. The band had almost completely obliterated the lumen of the small bowel. Greatly distended proximal loops of small intestine were found. The band was removed and the post-operative convalescence was normal until an enema was ordered on the third day. The enema caused abdominal pains and yielded a poor result. The surgeon then ordered a

\* It must be understood that the apparent reflex above mentioned was noted in abnormal intestine under abnormal conditions and with a balloon further upsetting the bowel.

high bowel wash-out. The result of this was an immediate and most marked distension within an hour. The distension was so intense that it interfered with respiration. Later vomiting began. The patient was then given  $\frac{1}{4}$  gr morphine four-hourly, with continuous duodenal suction by a Rehfuß tube. A day later distension was noticeably less and occasional movements could now be heard on auscultation of the abdomen. Within three days the distension was completely relieved, the tube was removed, and convalescence from then on was uneventful.

Incidentally, this case shows how an early stage of paralytic ileus can be treated by morphine to forestall the advent of an irreversible stage which would require the use of the Miller-Abbott tube.

Other cases are here quoted to show how stimulative treatment in the second stage of bowel movement following operation can bring about a paralytic ileus —

*Example 33* — In a patient, following an interval appendectomy, colicky central abdominal pains unrelieved by morphine set in on the evening of the second day. An enema was given and retained without distress to the patient. The pain was unrelieved and a second enema of milk and treacle with 1 c.c. of pituitrin was given, again without relief of pain, and the enema was also retained. Following this enema, distension became greater. The next morning the pain had ceased but the distension was intense and was interfering with respiration. The patient was then treated with injections of morphine, and the bowels were opened, by an enema, on the sixth post-operative day.

*Example 34* — Following a gynaecological operation a patient complained of slight colicky abdominal pains on the second day. She was given an enema without relief and without result. On the following day she was given pituitrin and an enema, with slight flatus result and slight relief of the colicky pain. Following the enema, however, the distension became more marked. The next day she was given another enema and more pituitrin, again with only a small result and increased distension. By the fifth day she had a well-developed paralytic ileus and a Miller-Abbott tube had to be passed.

*Example 35* — A middle-aged woman had had a vaginal hysterectomy performed and two days after operation became distended and complained of abdominal pain. On several occasions she was given pituitrin and enemas, each time with slight relief of discomfort, but more distension. Cascara and paraffin were given to her without result or discomfort. When, on the fourth day, she was given  $\frac{1}{4}$  gr morphine four-hourly, her distension lessened day by day until her bowels were opened on the sixth post-operative day.

The 'third stage' of recovery from paralytic ileus, or the recovery of movement following operation, is when once more peristalsis is co-ordinated, regular, and painless. In this stage enemas, pituitrin, bowel wash-outs, etc., produce a result with relief of any symptoms.

Thus, the writer puts forward the concept that there are three stages of ileus: (1) The stage of no movement (paralytic), (2) A stage of disordered and unco-ordinated movement, (3) A stage when movement is being co-ordinated once more.

It is suggested that this concept of ileus should serve as a basis for prophylactic and rational treatment of paralytic ileus.

## THE TREATMENT OF PARALYTIC ILEUS

From the results of these experimental inquiries and of these clinical studies the following basic principles emerge in regard to the treatment of paralytic ileus —

1 That in an ileus or bowel obstruction the chief cause of death is the result of increased permeability of the capillaries of the gut wall, the viability of which has been impaired (a) from the action of bacteria from within, and (b) from interference with the circulation by distension. Therefore therapy must be aimed at a reduction of internal pressure to circumvent the impairment of the capillaries, or at an increase of tone in the circulation to prevent an increase of the distension to the point of irreversibility.

2 That 'true' paralytic (idiopathic) ileus is rare. Many cases which were regarded as idiopathic, were really caused by areas of peritonitis or pockets of infection, toxic or traumatic.

Paralytic ileus caused by infection was often a semi-mechanical obstruction caused by a segment of small bowel which had become paralysed and incapable of passing on intestinal contents because it lay in a focus of pelvic peritonitis or formed part of the wall of a pelvic abscess.

A history of colic, the result of auscultation of the abdomen, and X-ray examination all help to make the important differential diagnosis of this condition from a true mechanical obstruction.

3 That there should be a careful consideration early in every case of paralytic ileus, as to whether or not a mechanical obstruction is present. The paralytic ileus can be a final stage of a neglected mechanical obstruction. If this is the case, and it is not promptly relieved, no exhibition of drugs, intestinal intubation, or other treatment will save the patient's life.

## A BASIS OF RATIONAL TREATMENT

**Prophylaxis** — As the result of this clinical study and concept of paralytic ileus, the following treatment is advocated —

1 No cathartics should be given before operation.

2 Gentleness of manipulation during operation, the avoidance of peritoneal contamination with pus, particularly in cases of localized appendicular abscess, as few surfaces denuded of peritoneum as possible should be left which might give rise to a reflex inhibition of intestinal movements, and packing should never be left in the peritoneal cavity.

3 In the first twelve hours following an operation, fluid should not be 'forced', since the stomach at this stage usually empties very slowly, and the intestines do not move to enable absorption to occur. Sipping of fluid at this stage must lead to swallowing of much air, which has been shown to be one of the main constituents of the 'gas' in ileus.

4 In the immediate post-operative phase the giving of atropine and barbiturates should be kept at a minimum, and morphine should be substituted for these drugs.

5 Stimulation by enemas, pituitrin, eserine, etc., should not be carried out during the first or second stages of the 'active' ileus which usually follows



any abdominal operation. Such treatment should be given only when there is some certainty that the third stage has been reached. This means that the hearing of abdominal borborygmi is not an indication for immediate stimulation. If it is accepted that the first returning bowel movements are irregular and unco-ordinated, it is unwise to give enemas or pituitrin until all danger of this stage has passed, usually this is after the third day. Since no harm results from leaving the bowels unopened for five, six, seven, or more days, it is in the author's opinion safe to give an enema any time after the fourth day, when the patient feels as if his bowels need opening. In many cases he has found that after the fourth day the bowels open normally without the aid of an enema or cathartics.

Where there is a possibility of the development of any grade of peritonitis and/or ileus, it would appear to be a good practice to put the patient on  $\frac{1}{2}$ – $\frac{3}{4}$  gr of morphine four-hourly for its action in increasing the tone and the mixing movements while decreasing the propulsive bowel movements, and to administer penicillin and sulphonamides rather than enemas.

The following case histories, chosen from a number, illustrate the effect of repeated injections of morphine,  $\frac{1}{2}$  gr, given strictly four-hourly to cases of incipient ileus—that is, cases in which distension and vomiting are present. They also illustrate the fact that when morphine injections are given for four or five days the bowels often open spontaneously.

*Example 36*—A woman aged 59 years had had four previous operations for obstruction and adhesions following an original operation of hysterectomy. When seen on this occasion she had been vomiting for a day, was considerably distended, and repeated enemas had produced no result. At operation numerous adhesions were divided throughout the lower small bowel. Following operation she had no audible bowel movements for two days, and after this she became somewhat distended. She was given  $\frac{1}{2}$  gr morphine four-hourly, and her bowels opened without aid on the sixth day after operation.

*Example 37*—A man aged 35 years had an operation for acute appendicitis and generalizing peritonitis. A drainage tube was inserted. On the second day, when he became somewhat distended,  $\frac{1}{2}$  gr morphine was given four-hourly. His bowels were opened with a small enema on the fifth day after operation.

*Example 38*—A man aged 59 years was operated upon for gangrenous appendicitis and general peritonitis. He became somewhat distended on the second post-operative day, when sounds could be heard in the abdomen. He was then given  $\frac{1}{2}$  gr morphine four-hourly. Following this the distension became less, he lost his feeling of acute abdominal discomfort, and his bowels were opened on the sixth day without the aid of enemas.

*Example 39*—A woman aged 30 years had an operation for acute appendicitis with generalizing peritonitis. She was much distended before operation, and following operation continued to vomit and show marked distension, though she had tumultuous abdominal sounds on auscultation after the second day. She was given  $\frac{1}{2}$  gr morphine four-hourly. Her vomiting then ceased and her distension improved a little. Her bowels were opened six days later, after a small enema.

*Example 40*—A woman aged 59 years complained that five hours before being seen she began to have colicky

pains across the umbilical area, and soon after this to vomit. An indefinite mass could be felt above and to the left of the umbilicus. At operation a strangulated hernia into the paraduodenal fossa was reduced. It was only after considerable deliberation that it was decided not to resect. On the second day after operation she became distended,  $\frac{1}{2}$  gr morphine was given four-hourly, and from then her convalescence was satisfactory.

**Treatment of Fully Developed Paralytic Ileus**—If distension is present and there are no movements to be found on auscultation, the patient has developed a paralytic ileus, and if he is not very distressed or upset, it is reasonable to treat him by giving morphine,  $\frac{1}{2}$  gr four-hourly, by passing an indwelling duodenal tube, and by attention to his fluid balance and serum protein concentration.

But in the case of a fully developed 'irreversible' paralytic ileus where the patient is very sick and distended, there is no question but that the use of the Miller-Abbott tube together with replacement therapy is the only way to save his life. It is also the only means by which an overdistended bowel can be reduced in calibre (that is, by the suction of a 'travelling ileostomy') to such a size that once more normal absorption from the loops can be established. It is in fact the only way of breaking the vicious circle of distension and lack of absorption in the stage of 'irreversible' ileus.

The adoption of the Miller-Abbott tube method often hinges on the difficulty of introducing the tube. The methods which will facilitate its introduction have been discussed in detail in a paper by John Devine (1945). There are very few cases in which with patience and practice it cannot be introduced with reasonable certainty into the duodenum by one of the methods described. Since the Miller-Abbott tube is the only means of curing a fully developed irreversible paralytic ileus, its introduction should be certain. Yet all figures quoted show that in a large number of the cases the tube could not have passed through the pylorus. Thus Smith (1945) mentioned that, despite the use of mercury in the balloon, for 1000 cases where intubation was attempted there were 221 failures. Other authors also publish a high percentage of failures.

In the present series of 43 successful intubations 41 were successful by the oral route. In this series were two cases in which the patients had a paralytic ileus, and were desperately ill. One had had the tube successfully passed twice before, but he had become so ill that it could not be passed a third time orally. The other had three times pulled out a tube which had been successfully introduced through the nose. In both instances the tube was then introduced through a small jejunostomy opening made under local anaesthesia.

To introduce the Miller-Abbott tube through a jejunostomy opening, when there is difficulty in passing it through the pylorus, is a logical procedure. It has been pointed out that an ileostomy in these patients is not sound treatment, in one case paralytic ileus actually developed after this operation. It is logical, therefore, that if in a desperately ill patient a Miller-Abbott tube, which provides a 'travelling ileostomy', cannot be passed by the normal way, and is needed for the patient's recovery, it should be

introduced through a jejunostomy Temporary jejunostomy has been practised as a routine following gastric operations by some surgeons who prefer it to subjecting their patients to the annoyance of a nasal Abbott-Rawson tube The opening in the jejunum should, however, be made as high as possible so as to empty the whole jejunum In both the cases cited below, the Miller-Abbott tube successfully emptied the small intestine and reduced the distension But in the first case death occurred later from an operatively unrelieved mechanical intestinal obstruction, and in the second from lung embolus There does not appear to be any mention in the literature of this route for the introduction of the Miller-Abbott tube, which in many cases may be preferred by both surgeon and patient to the usual oral method

*Records of Cases in which the Miller-Abbott Tube had to be Introduced through a Jejunostomy —*

*Example 41* — There had been bleeding following a gynaecological operation, and packing had been introduced into the pelvis, resulting in a paralytic ileus which was relieved by intestinal intubation with a Miller-Abbott tube in the normal manner Peritonitis developed four or five days later and a Miller-Abbott tube was again passed After four days more this appeared to have been controlled by chemotherapy and the tube was removed However, distension once more occurred, and on this occasion, as the patient was very ill, it was found impossible to get the tube to pass the pylorus, though by means of a stylet and X-ray control it was kept against the pylorus for twenty-four hours The tube was then passed through a jejunostomy under local anaesthesia, and eight hours later the first peristaltic movements were noticed on the recording apparatus, and thenceforth the tube was introduced at the rate of 4 in an hour Gas and fluid were withdrawn and the distension relieved Subsequently the patient was operated upon under a local anaesthetic and a mass of adherent intestines was found and an ileostomy performed Pneumonia supervened and death occurred several days later

*Example 42* — The case of a boy aged 19 years, who had an ileostomy performed as a preliminary to colectomy Paralytic ileus supervened on the fourth day On the fourth night the Miller-Abbott tube was passed, and by next morning was apparently coiled in the stomach and not through the pylorus (*Fig 239*) Further attempts were made to pass the tube through the pylorus, and by that evening it was apparently through However, at this stage the patient pulled out the tube It was again introduced, and again after six or seven hours, when it appeared to be through the pylorus, it was pulled out by the patient On the sixth post-operative day, under local anaesthetic, the tube was introduced through a jejunostomy (*Fig 240*) A small right upper paramedian incision was made, and a very dilated dusky loop of intestine presented This was deflated with a hypodermic needle fitted to the sucker, and then this was sewn into the peritoneal opening with a continuous catgut suture Two purse-strings were then put in the bowel, which was opened, and the Miller-Abbott tube introduced to a distance of 3-4 in A long silk suture was then attached to a big bite of bowel and let out through the wound so that when the tube was being pushed in counter-traction could be made on the thread The wound was sewn up in the usual way

Four hours after the operation, peristalsis was observed on the recording mechanism (*Fig 238*), and thereafter the balloon was introduced at the rate of 3 in an hour, and 40 oz of fluid of a dark-brown colour was removed, together with the passage of much flatus, and the distension of the

lower abdomen disappeared (*Fig 237*) However, the upper part of the abdomen remained distended, and when a nasal Rehfuß tube was passed, it removed 128 oz of dark-brown stomach contents Following removal of these contents, peristalsis in the small intestine became much more marked The patient was, meanwhile, given intravenous serum and saline in an endeavour to catch up on the huge negative fluid balance

After two days of intestinal decompression by the Miller-Abbott tube through the jejunostomy opening, the tube was withdrawn to the 75-cm mark and the patient fed with 2 oz of glucose egg-flip every two hours through the suction lumen His condition appeared to improve, but large quantities of fluid were still being periodically sucked out of his stomach Successive gastric aspirations removed 100, 60, and 28 oz

On the ninth post-operative day, three days after the intestinal intubation through the jejunostomy, the patient once more became slightly distended, and when the balloon was blown up no peristalsis was observed At this stage another attempt was made to pass a second Miller-Abbott tube through the stomach from the mouth This had successfully passed the pylorus when the patient (always difficult) pulled out the tube once more After a difficult twelve hours, during which no peristalsis could be recorded from the balloon on the Miller-Abbott tube, which had been introduced through the jejunostomy, peristalsis once more commenced, and again the Miller-Abbott tube was passed through the small intestine at the rate of 4 in an hour, this time removing much more normal looking small-bowel contents The ileostomy below now commenced to work, and after the small intestine had been emptied by the Miller-Abbott tube it was withdrawn to the 75-cm mark and used as a jejunostomy feeding tube and the patient fed two-hourly with glucose egg-flips

On the eleventh day the patient had a perfectly flat and soft abdomen, and jejunostomy and ileostomy were both acting freely, but on the twelfth day he died suddenly from lung embolus

This case illustrates the fact that the jejunostomy method of introduction of the tube is useful because besides being a method of introduction of the tube in difficult cases, it forms a useful way of feeding the patient in a case with acute gastric dilatation

It should be pointed out that the Miller-Abbott tube should not be used for all cases of incipient ileus, as there are difficulties and dangers in its use Also it is unpleasant for the patient to have for a long time an indwelling tube of fairly thick calibre which gives rise to pharyngeal and laryngeal irritation and, if used intranasally, to marked rhinitis However, in the 'irreversible' stages of ileus, its employment should not be withheld too long Further, it is no more annoying to the patient than an ordinary stomach tube, and even if it is not made to pass out of the stomach to the small bowel, it at least does the work of a stomach tube and has the potentiality of doing more

**Replacement Therapy** — The patient with paralytic ileus is indeed a 'test-tube baby', for when large amounts of fluid are withdrawn suddenly from the bowel, sudden dehydration and a condition resembling shock may supervene Though the intestinal fluid is theoretically outside the circulation, there appears to be a constant 'give and take' of fluid through the bowel wall, which appears to be less selective and more "permeable" as a result of distension

The route of replacement is important Since saline, glucose, and serum are usually required, the intravenous route is the one of choice

Pressman, 1930), but the higher the concentration of saline the slower the absorption, therefore it is better to give tap water In any case, if absorption

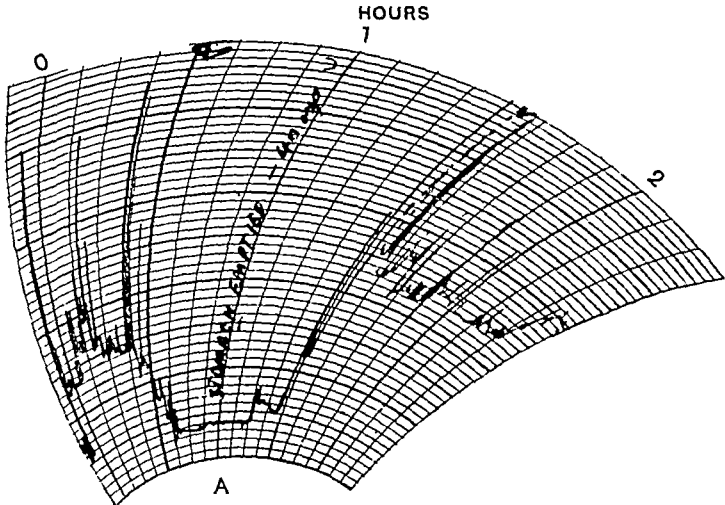


FIG 237—Example 42 To show the effect on peristalsis of distension of the stomach and its relief at point A

Careful charting of the fluid balance is essential—it is too late when œdema or crepitations at the lung bases herald hyperhydration

Glucose is probably absorbed in the colon in amounts insufficient to stimulate the pancreas, and if anything lowers the blood-sugar (Ebeling, 1933 ,

is not immediate it may act as a bowel wash-out and stimulate small-bowel peristalsis

Serum should be administered as the serum-protein is usually low A very quick estimation of the serum-protein concentration can be made by the copper sulphate method, which has been used as a

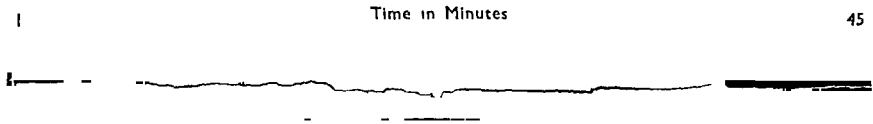


FIG 238—Example 42 To show the first movements commencing five hours after laparotomy under local anæsthetic to place the Miller-Abbott tube in the jejunum



FIG 239—Example 42 Showing Miller Abbott tube coiled in the stomach and small stomach pressed up under the diaphragm by distension

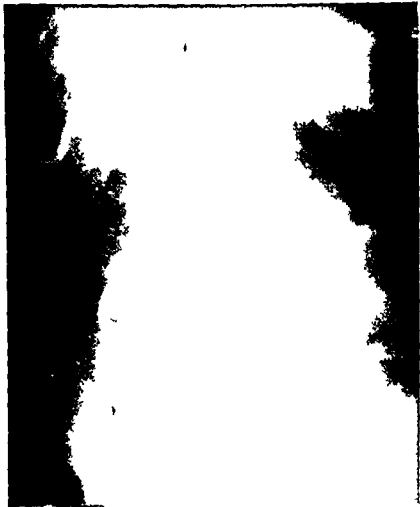


FIG 240—Example 42 The tube has been introduced into the loop of jejunum through the jejunostomy made in the abdomen under a local anæsthetic The lower abdomen is being compressed, but several loops of upper jejunum can still be seen to have a ladder pattern present

routine by the author in all cases where intestinal intubation has been performed (Van Slyke et al, 1944) This method requires at most 2 c c of blood and takes about a minute to centrifuge, after which a drop of the serum or plasma is dropped off a pipette into copper sulphate of various strengths. Copper sulphate and the protein in the serum form an insoluble compound, and for twenty or thirty seconds the drops either rise or fall, depending on whether they are in a solution of equal specific gravity or not. They then dissolve and the solution can be used again and again. Knowing the density of the solution in which the drop hangs suspended, the specific gravity of the serum or plasma is immediately apparent, and from it the serum-protein or

concentration is undesirable (Shay, Gershon-Cohn, Fels, and Munro, 1940)

The most striking evidence of the duodenal absorption of glucose occurred when, as a result of a congenital defect, a baby had only a few inches of duodenum brought out on to the abdominal wall and no remaining small bowel. Marked rise in the blood-sugar level occurred when glucose solution was fed into the duodenum (Hendtlass, 1943)

When the Miller-Abbott tube is down the intestine it is most desirable that the patient be given a high-carbohydrate and high-protein diet. A most useful method of accomplishing this has been the giving of glucose egg-flips made with citrated milk. This solution has also been used in two cases in

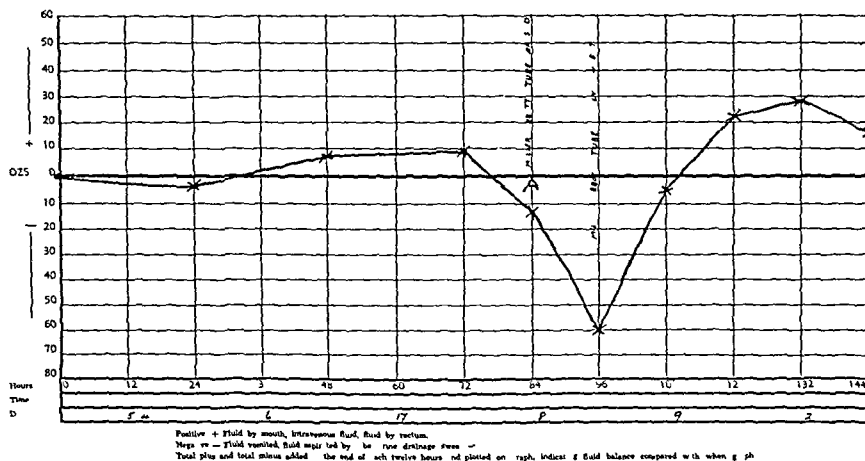


FIG 241—To show how the fluid balance was recorded in a case of paralytic ileus—intravenous fluids were being administered continuously—a Miller-Abbott tube was passed at A

plasma-protein concentration can be read off on a table. The patient is also put on a water balance chart (Fig 241)

Serum should be given at the rate of at least a litre a day, even though the serum-protein is not initially low, as very little serum is being absorbed from the bowel.

Wood and Bick (1941) found sodium chloride deficiency and some degree of acidosis in six of the cases they studied of paralytic ileus obstruction. Chew Smith and Van Beuren (1943) state that with the Miller-Abbott tube during the acute phases of ileus fluid replacement should average 2900 c c per day.

Quite apart from the value of serum and sodium chloride solutions in replacement therapy, they increase intestinal peristalsis.

The type of intravenous saline and glucose used should be considered. It has been found that the average salt content of the intestinal fluid removed in obstruction is 0.6 per cent (Abbott, 1942). Thus it is usual to give two litre flasks of 5 per cent glucose in saline followed by one of 5 per cent glucose, thus giving back to the patient a fluid with the same amount of saline content as the aspirated fluid, and thus restoring the fluid and saline balance.

When the Miller-Abbott tube has passed down the bowel from the stomach the patient may be fed above the tube, for glucose at least is absorbed in the duodenum and upper jejunum, but too high a glucose

concentration is undesirable (Shay, Gershon-Cohn, Fels, and Munro, 1940)

When a tube is down, there is a marked loss of bile-salts, which may be replaced by capsules containing bile-salt given by mouth. Vitamins B and C are also indicated.

## SUMMARY

1 The results of the clinical study of a number of cases of paralytic ileus, and of 43 cases in which intestinal intubation with the Miller-Abbott tube was performed, and of a number of observations on patients with ileostomies and jejunostomies and X-ray observations, are presented.

2 True or idiopathic post-operative paralytic ileus is rare. It is a dangerous diagnosis to make in a case of post-operative ileus, for it often serves as a solace to the pride, and prevents a correct diagnosis of the real cause till it is too late for appropriate treatment.

3 As a result of a study of drugs and procedures that might influence small-bowel motility in the prevention or treatment of paralytic ileus, it was found that—

- a Heat or turpentine stipes on the abdomen had no effect on bowel movements
- b Barbiturates (luminal) decreased peristalsis and tone
- c Penicillin and sulphonamides did not materially affect peristaltic movements

d Over-distension of the stomach caused loss of tone and decreased movement of the small bowel

e Stimulation of the large intestine by enemas also stimulated the small intestine, even when this was completely isolated from the colon

4 By far the most frequent cause of a post-operative ileus is a degree of post-operative intra-abdominal infection

5 From a study of Miller-Abbott recordings and abdominal sounds in regard to the return of intestinal movements after operation, and the return of these movements during recovery from paralytic ileus, emanates what the author regards as an important hypothesis viz, that there are three phases of ileus Stage 1, in which the movements are active, co-ordinated, responsive to stimulation, and effective, Stage 2, when they become irregular, inco-ordinated, and are ineffective, and Stage 3, when the intestinal movements disappear and completely fail—in other words a fully-developed paralytic ileus Stimulation in the second stage will often precipitate a fully-developed paralytic ileus

6 A rational scheme of prophylactic and active treatment for paralytic ileus is based on these three stages

7 Two cases in which the Miller-Abbott tube was introduced through a jejunostomy under local anæsthetic are reported It is considered that in desperate cases jejunostomy and the introduction of a Miller-Abbott tube into the bowel by this route is more logical than ileostomy, which drains only the loop in which the opening is placed

8 In view of the potential danger of such weapons as the enema and cathartics when given at the wrong stage, the delegation of the responsibility for their use to the nursing staff is much to be deplored

I wish to thank Professor R D Wright, of Melbourne University Physiology School, for never-failing help and stimulative criticism, and the many nurses and sisters, particularly those of the "Mercy" Hospital, for their help in the arduous nursing and detailed recording

## APPENDIX

### Adynamic Ileus —

#### I Intra-abdominal —

##### A Peritoneal irritation —

###### 1 Traumatic —

- a Post-operative
- b Penetrating wounds

###### 2 Bacterial Peritonitis

###### 3 Chemical —

- a Extravasation of blood
- b Perforated peptic ulcer
- c Bile peritonitis
- d Acute pancreatitis

EARLY

##### B Vascular changes —

###### 1 Strangulation —

- a Intramural Distension following mechanical ileus
- b Extramural Compression of the mesenteric vessels

###### 2 Mesenteric thrombosis

##### C Extraperitoneal irritation —

###### 1 Hæmorrhage

###### 2 Infection

###### 3 Renal

#### II Extra-abdominal —

##### A Toxic —

- 1 Pneumonia
- 2 Uræmia
- 3 Empyema
- 4 Systemic infection

##### B Neurogenic —

- 1 Injuries and diseases of the spinal cord
- 2 Lead poisoning
- 3 Fracture of the lower ribs

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## RECONSTRUCTION OF BICEPS BRACHII BY PECTORAL MUSCLE TRANSPLANTATION

BY JOHN M P CLARK

HON ASSISTANT ORTHOPÆDIC SURGEON LEEDS GENERAL INFIRMARY

THE problem of reconstituting the biceps brachii arises most often in dealing with the aftermath of anterior poliomyelitis and only occasionally as a result of trauma. More or less complicated procedures have been described, but the operation which is the subject of this paper is technically simple to perform and, in the one case in which it has been tried, the result has proved satisfactory enough to suggest that it might, with advantage, be more widely employed.

The pectoralis major has been called by Keith 'the climbing muscle' and it was conjectured that such an action could still be used after the origin of the muscle had been transferred to the biceps tendon in the arm providing the nerve-supply of the transplanted fibres could be kept intact. In mammals, Keith (1933) describes a third pectoral muscle—the pectoralis externus—arising from the fourth, fifth, and sixth ribs and costal cartilages beneath the axillary border of the pectoralis major—and states that in man this muscle is commonly fused with, and forms part of, the pectoralis major. On the basis of this statement it seems reasonable to expect the outer portion of the pectoralis major to have a nerve-supply separate from the remainder and that it would be possible to construct a viable transplant from this part of the muscle. These arguments appear to be justified by the findings at operation and by the clinical result of the operative procedure founded upon them.

### CASE REPORT

On Oct. 14, 1944, a German soldier sustained a shell wound of his left upper arm which caused extensive laceration of the biceps and coracobrachialis muscles with musculospiral nerve palsy. By the time the patient had reached a casualty clearing station gas gangrene had developed in the damaged muscles. On Oct. 15 the wound was excised and the biceps and coracobrachialis muscles were completely removed, the torn ends of the musculospiral nerve were seen. The wound was left open. 180,000 units of anti-gas gangrene serum were administered and a course of penicillin given intramuscularly for four days. One month later secondary suture of the wound was performed and satisfactory healing was obtained. A full range of passive movement was maintained in the elbow, wrist, and finger-joints, the musculospiral palsy was complete in the forearm and the action of the triceps was weak.

Five and a half months after wounding tendon transplantation was performed to restore extension of the wrist and digits. The result was satisfactory, but supination was weak and pronation absent. At the elbow there was no active flexion, but by a combination of weak triceps action and gravity full extension was present.

The use restored to the hand was such that the patient was anxious that something should be done for his arm. Reconstruction of the biceps was therefore undertaken by the method to be described.

**OPERATIVE TECHNIQUE**—The patient was placed in a supine position with the affected arm half abducted and supported in full extension on a side table. The first

incision reached from the level of the apex of the axilla distally along the axillary border of the pectoralis major to the seventh rib. The skin and superficial fascia were reflected to expose the underlying pectoral muscle and to define its lateral border and its lower costal attachment. The origin of the exposed muscle from the anterior surface of the sixth rib, together with its covering fascia, was detached to provide a piece of tissue  $2\frac{1}{2}$  in wide. By separating the pectoral fibres along a line parallel to the muscle's axillary border a transplant large enough to act as a substitute for the biceps was isolated. One of the main terminal branches of the lateral anterior

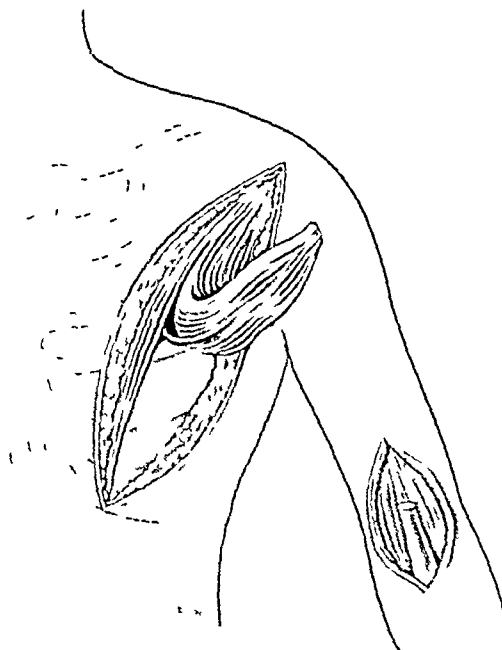


FIG. 242.—Showing the pectoral muscle turned upwards exposing the lateral anterior thoracic nerve.

thoracic nerve, which first appears at the level of the intercostal space between the third and fourth ribs, runs distally along the deep aspect of the lateral part of the great pectoral muscle and supplies it, its calibre is about equal to that of an intercostal nerve. As the separated part of the muscle was turned upwards the loose fascia under it was stretched and the nerve assumed an approximately horizontal position and was easily seen and preserved (Fig. 242).

A second incision was then made on the anterior aspect of the lower third of the upper arm and the remains of the biceps tendon were exposed and mobilized. With the aid of a pair of long-bladed forceps thrust up from the incision in the arm a subcutaneous tunnel communicating with the upper end of the first incision was fashioned, through which the pectoral transplant was threaded. The lower part of the chest incision was then sutured, leaving sufficient of the upper part open to allow the tension on the nerve supplying the transplanted

muscle to be observed during the remainder of the operation. It was found that the transplant could not be drawn down the arm to its fullest extent because its nerve became stretched over the floor of the axilla even when the arm was fully adducted. The elbow was then flexed to a right angle and the tendon stump was looped through the distal end of the transplanted muscle and sutured to itself. Additional sutures were used to close the breach in the muscle and to fix it securely to the

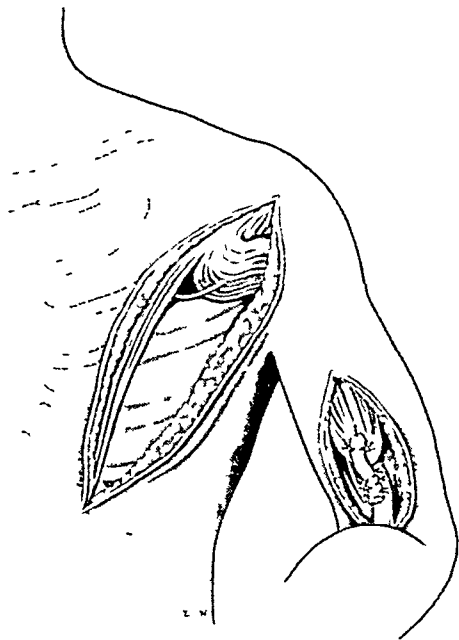


FIG 243 —The muscle transplant completed

penetrating tendon (Fig 243). As shown in the diagram, the direct line of pull of the transplant was a little interrupted by the medial bulge caused by the stretched nerve, but there was no portion of the muscle sufficiently slack to suggest that its power would be vitiated. The incisions were closed and the arm was placed in a sling with the elbow maintained at a right angle

**POST-OPERATIVE COURSE** —As soon as the patient was allowed out of bed he noted that, when walking and swinging his uninjured arm, he felt a little tug on the opposite forearm in the alternating phase of the swing. This demonstrated the integrity of the nerve-supply of the transplant, and kindled the patient's enthusiasm past damping. Immobilization in the sling was continued for three weeks and then, after removal of the skin sutures, active movements within the sling were started. The wounds were healed.

Six weeks after the operation full extension at the elbow was short only by  $20^\circ$  and active flexion to  $70^\circ$  was attainable, the transplant was palpably increased in size. Two weeks later the patient succeeded in flexing his elbow actively against a  $7\frac{1}{2}$ -lb resistance from its position of greatest extension to  $20^\circ$  short of a right angle—an excursion of  $50^\circ$ . The substitute muscle was now about three times its former size and on contraction closely simulated the action and appearance of the normal biceps. The arm was being used daily in the performance of sundry domestic duties.

Sixteen weeks after the operation the patient was repatriated, but before leaving he was examined by Major A S Bullough, R A M C, who reported that full active flexion of the elbow was short only by  $15^\circ$  and that full extension was short by  $5^\circ$ , and he estimated that the power of flexion was 40 per cent of normal. Flexion of the elbow was accompanied by a shrugging of the shoulder, but the patient had grown accustomed to this action and could easily initiate the movement required. Photographs of the arm in positions held actively were also taken (Figs 244, 245).

### SUMMARY

- 1 A portion of pectoralis major was used as a transplant to replace the biceps brachii which had been destroyed
- 2 The operative technique is described
- 3 The case is reported fully

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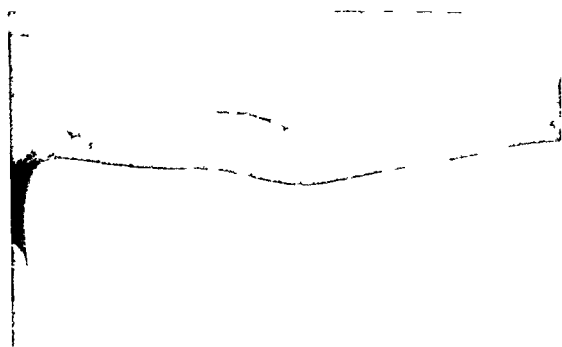


FIG 244 —Showing the arm fully extended

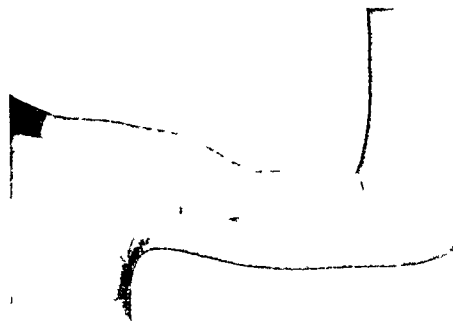


FIG 245 —Showing the arm flexed to a right angle



## TRIPPLICATE URETER

BY IRVINE SMITH

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THE incidence of duplication of the ureter (double and bifid ureters) is sufficiently common to lead any urologic clinic to expect at least a few cases each year, and has been reported in 0.5 per cent of autopsies (136 out of 26,480) by Meredith Cambell (1937) in his exhaustive book. Triplication (triple and trifid ureters) is, however, much rarer; Cambell found only 3 cases, those referred to and substantiated

Intermittent dilatation of the anus, aperients, and rectal wash-outs soon restored the bowel to normal. A later attack of gastro-enteritis cleared up after a fortnight, but the urine was not sterilized by two consecutive courses of sulphathiazole with mist pot cit alk, or by a subsequent course of mandelates with sod acid phosph.

On June 20 the urine still contained 70 mg albumin per 100 c.c., and grew *Ps. pyocyaneus* as well as *B. coli*, and the blood-urea was 37 mg per 100 c.c., so the patient

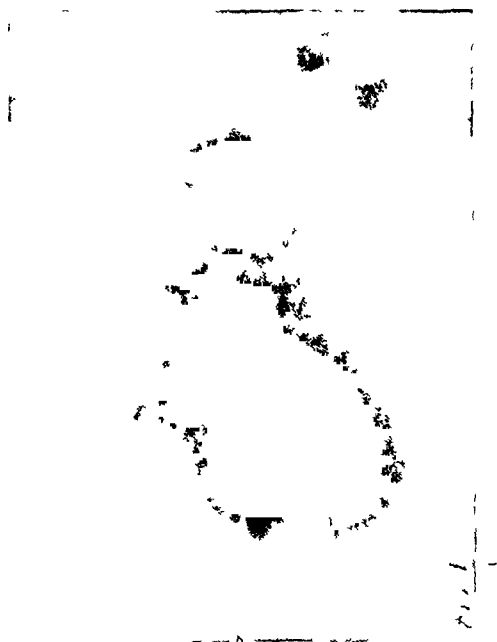


FIG 246—Cystogram with patient upside down, showing two linked hydro-ureters and two renal pelves

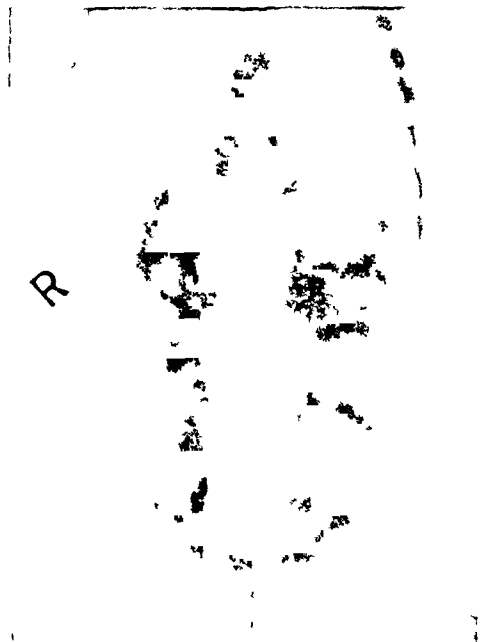


FIG 247—Retrograde pyelogram showing normal ureter and pelvis on the right

by Lau and Henline (1931), who also collected references to inadequate records of 3 other cases.

One new case of trifid ureter is therefore described here, and 10 previously recorded cases of triple and trifid ureter, together with 3 cases which showed more than three ureters on one side, have been collected, summarized, and briefly discussed.

## CASE REPORT

C.P., a female aged 6 months, was brought to the Hospital for Sick Children on May 9, 1945, complaining of (1) frequent clay-coloured motions, (2) apparently painful defaecation. She had weighed 8 lb at normal delivery at full term, had been breast-fed for two weeks, and since then had been on Cow & Gate (F.C.).

Examination showed a moderately ill baby weighing 13 lb 5 oz, scratch marks on scalp, abdomen tense and swollen with palpable hard masses of faeces, anus extremely tight, rectum very full, the urine contained albumin, pus, and *B. coli*. The mouth, fauces, tonsils, ears, chest, and heart were clinically healthy. The urinary infection was considered to be secondary to the alimentary stasis.

was transferred back to Great Ormond Street for further investigation.

A cystogram with the patient tipped head downwards showed a normal bladder outline with two widely dilated and linked ureters on the left side (Fig 246). Cystoscopy on July 6 showed considerable cystitis, but only two ureteric orifices. The left orifice gaped considerably. Retrograde pyelography showed a normal ureter and pelvis on the right, though the pelvi-ureteric angle was a little accentuated (Fig 247).

Left Nephro-ureterectomy was performed through a left loin incision by Mr T. Twistington Higgins on July 18. The two dilated upper ureters were found arising one above the other from the upper pole of the kidney. A third ureter of normal dimensions and appearance was found arising from the lower pole (Figs 248, 249). The appearance of the kidney suggested the possibility of two closely apposed kidneys. Subsequent dissection failed to prove this, but showed that the upper pole containing the upper two pelves consisted of whitish and scarred tissue without any characteristic naked-eye renal pattern, while the lower two-thirds were pinker, with normal cortical and medullary patterns. The three pelves arose separately one above the other in

the middle plane of the kidney (*Fig 250*) At operation the ureters were dissected free as low as possible and divided at about 1 in above the bladder Down to this point the two thick ureters were enclosed in a common fibrous sheath, while the single healthy ureter remained quite separate from and lateral to the other two How they entered the bladder could not be seen from above, but cystoscopy had showed only one ureteric orifice on each side, so it is assumed that this was a trifid ureter,

unite and drain through a single orifice, viz, 'trifid ureter' (*Fig 251, c*) If two ureters arise from a kidney, the bifurcation of one of them before it reaches the bladder would constitute a triple ureter, such inverse Y bifurcation has been reported four times in association with reduplicated ureters (Cambell, 1937), and it is possible that Chwalla's case (*see below*) is of this type (*Figs 251, d, 252, C*)



FIG 248—Kidney, as removed, showing the ends of two thickened dilated ureters and a third normal ureter

FIG 249—Kidney showing two hydro-ureters from upper pole enclosed in a common fibrous sheath



FIG 250—Kidney, split in approximately the median plane, with a matchstick inserted through each pelvis into each ureter

with the components uniting just above or actually in the bladder wall (*Fig 252, K*)

Convalescence was complicated only by recurrence of slight faecal retention and the baby was discharged home on July 31, aged 8½ months, with the urine sterile and free from albumin, and the general condition very good

## TYPES OF TRIPLICATE URETER

If three ureters arise from a kidney (1) they may open into the bladder (or urethra or elsewhere) independently through three orifices, viz, complete

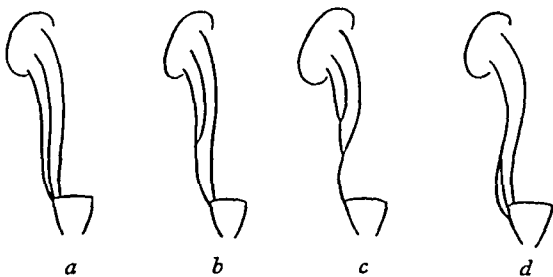


FIG 251—Types of triplicate ureter (a) Triple (b) Double with one bifid, (c) Trifid, (d) Double, with inversion Y bifurcation

triple ureter (*Fig 251, a*), two ureters may unite, leaving only two orifices, a condition I have called 'Double ureter with one bifid' (*Fig 251, b*)—I can find no record of any case showing a double ureter with both bifid, (3) all three ureters may

## PREVIOUSLY RECORDED CASES

The following are summaries and diagrams of previously recorded cases arranged according to this scheme —

**Triple Ureter** has been recorded four times, incidentally right-sided in each case Only *Case 1* was satisfactorily demonstrated as complete, in *Cases 2* and *3* the origin of one ureter remained obscure, in *Case 4* there was a vulval ectopic ureteric orifice

*Case 1* (Woodruff, 1941) —A man, aged 74, with right-sided triple ureter (*Fig 252, A*) which was found accidentally with routine investigations prior to a routine prostatectomy No symptoms A complete case, the original article contains an excellent pyelogram showing all three pelves and ureters

*Case 2* (Lau and Henline, 1931) —A negress, aged 52, with right-sided triple ureter had complained of frequency, dysuria, with lumbar and crural pain for four years Cystoscopy showed three ureteric orifices on the right The first and second secreted dye in 10 min, the third none, and could not be catheterized beyond 1 cm Retrograde pyelography showed the first two draining a double kidney, and the third ending in an irregular small cavity in front of the lumbosacral junction This was taken to represent an ectopic mal-developed accessory right kidney (*Fig 252, B*)

*Case 3* (Chwalla, 1935) —A man, aged 41, with a right-sided triple ureter was a tabetic being investigated for vesical calculi Cystoscopy showed three ureteric orifices on the right, all secreting dye in 3-4 min Intra-venous pyelography showed on the right three ureters,

but only two renal pelvises. *Retrograde pyelography* suggested that the two lateral ureters both drained the lower pelvis, and possibly represented the bifurcation of a single ureter at the level of L 4-5 disc (Fig 252, C). The patient refused further investigation.

**Case 5 (Wrany, 1870)**—A girl, aged 3, with left-sided double ureter, one bifid, died of encephalitis and chronic subdural hæmatoma. *Autopsy* showed the left kidney rotated hilum forwards, with two pelvis arising side by side in the lower half of the kidney, each giving rise to a

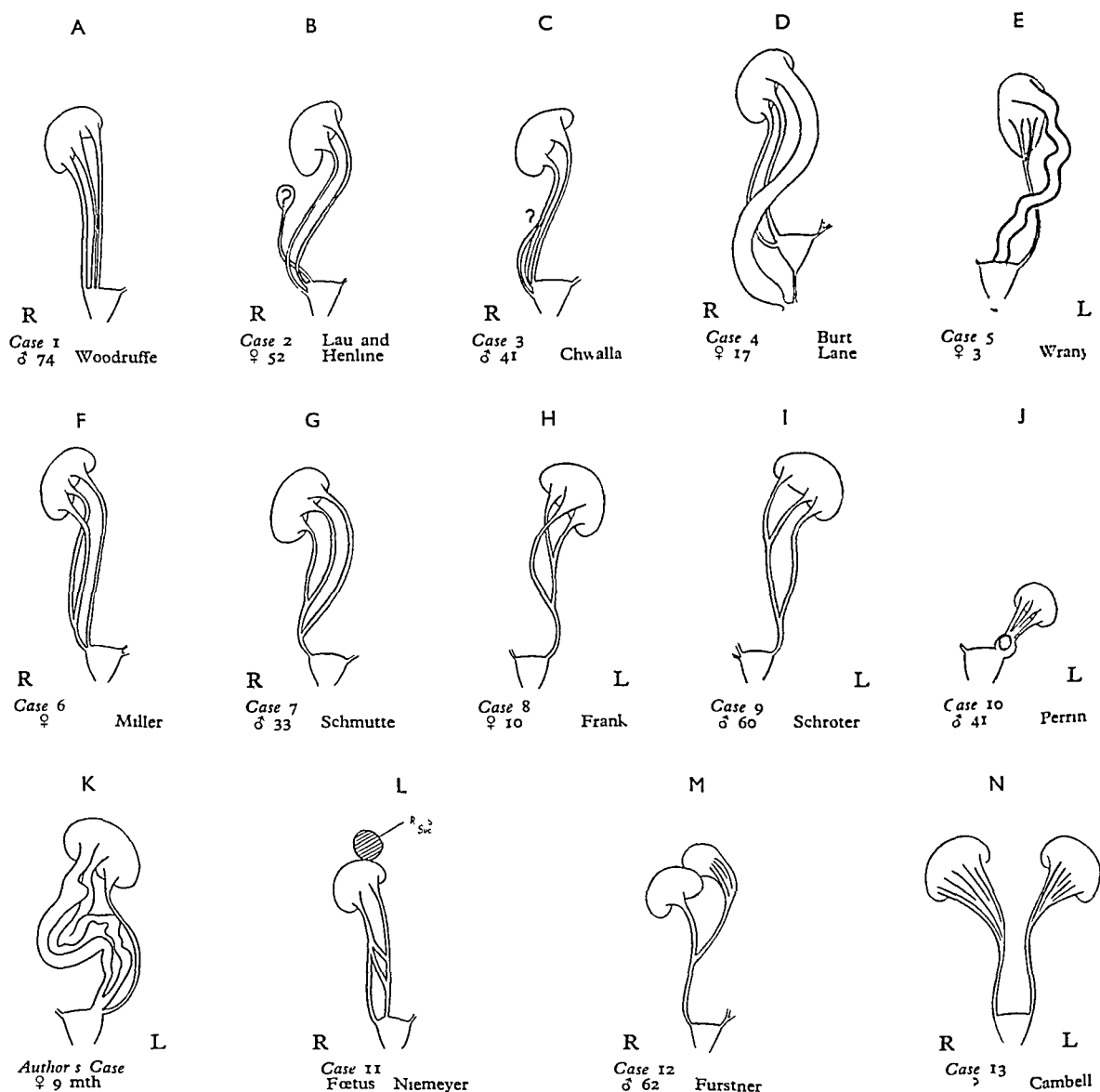


FIG 252.—Diagrams showing the arrangement of the ureters in the cases reported

**Case 4 (Burt et al, 1941)**—A girl, aged 17, with right-sided triple ureter was being investigated for incontinence since birth. *Cystoscopy* showed two ureteric orifices on the right, but intravenous injection of dye revealed a pin-point orifice in the vulva just to the right of the urethral meatus. *Intravenous pyelography* showed three pelvises and three ureters on the right, the upper one being very dilated and leading to the ectopic orifice (Fig 252, D). *Operation* showed three ureters arising from the pelvises of a normal kidney.

**Double Ureter with One Bifid** has been recorded twice, in each case the lower ureter was bifid and the upper was separate.

normal ureter. These united 4 in below the kidney. A third pelvis situated in the lower pole gave origin to a thick-walled tortuous hydro-ureter, which ran downwards lateral to the other two, crossed anterior to them, and opened into a membranous diverticulum of the bladder just above the urethra (Fig 252, E). This diverticulum, hydro-ureter, and upper pelvis were heavily infected and the corresponding renal tissue was hydronephrotic.

**Case 6 (Miller, 1938)**—Miss H, with right-sided double ureter, with one bifid, complained of backache, and her urine grew *B. coli*. *Cystoscopy* showed two ureteric orifices on each side. *Retrograde pyelography*

showed three pelves and three ureters on the right, the two lower ureters, after crossing high up, united in front of the sacro-iliac joint (Fig 252, F)

**Trifid Ureter** has been recorded four times. The pattern of trifurcation was different in each case

**Case 7** (Schmutte, 1929)—A man, aged 33, with right-sided trifid ureter, underwent an operation for subcapsular hæmatoma. The specimen removed was a small ectopic kidney,  $7.5 \times 3.2$  cm, floating in a subcapsular hæmatoma low down on the anterior surface of the psoas. One pelvis in the upper pole and two pelves side by side in the lower pole each gave origin to a normal ureter. Cystoscopy later revealed only one ureteric orifice on the right (Fig 252, G)

**Case 8** (Frank, 1933)—A girl, aged 10, with left-sided bifid ureter and a patent interventricular septum, died of pneumonia after an operation for repair of epispadias. Autopsy showed three pelves arising one above the other from a normal sized left kidney. Each gave rise to a normal ureter, of which the upper and the lower united  $\frac{1}{2}$  in below the kidney, and were joined 2 in farther down by the third, thus entering the bladder on the left through a normal single orifice (Fig 252, H)

**Case 9** (Schroter, 1937)—The cadaver of a man, aged 60, with left-sided trifid ureter was dissected at Leipzig University. Each kidney has two "hiluses". The left upper hilus gave origin to a normal pelvis and ureter. The left lower hilus gave origin to two pelves and two ureters, one above the other and all appearing normal, except that the middle pelvis was much smaller than the other two. The two upper ureters united 16 cm below the kidney and were joined 6 cm above the bladder by the third (Fig 252, I)

**Case 10** (Perrin, 1927)—A man, aged 41, with left-sided trifid ureter and an ectopic left kidney had three attacks of left lumbar pain with frequency and hæmaturia. The urine grew streptococci. Cystoscopy showed blood coming from a single orifice on the left. Pyelography showed a sacral ectopic hydronephrotic small left kidney. Operation showed this lying in the hollow of the sacrum and giving rise to three ureters which soon united to form a small sac which drained into the bladder through one orifice and contained a large calculus. The outlets of the two upper ureters were obstructed by this stone. This specimen was demonstrated to the Royal Society of Medicine by Mr Perrin on March 24, 1927 (Fig 252, J)

**Multi-branched Ureters** have been reported, but the branching is usually very close to the kidney, and the ducts possibly attenuated calices of metanephric origin rather than true ureters

**Case 11** (Neimeyer, 1814)—A full-term female foetus with four branches to its right ureter amongst many other congenital deformities was the thirteenth infant of a woman of 40. Neimeyer's diagram (reproduced in a simplified form in Fig 252, L) does not tally closely with his text, which, literally translated, reads "from the anterior side of the right kidney, which resembles a renal pelvis, proceeded four tubules separating at some points and uniting at others and passing beneath the rudimentary vagina"

**Case 12** (Furstner, 1897)—A man, aged 62, with a five-branched ureter died from pulmonary and miliary tuberculosis. Autopsy showed bilateral bifid ureters. The upper right ureter arose "from five wide canals" which began in the five calices of the smaller partly separate "appendage of the right kidney" (Fig 252 M)

**Case 13** (Cambell, 1937)—Bilateral six-branched ureters were found in an adult at autopsy at the Bellevue Hospital, New York. No further details were given (Fig 252, N)

## DISCUSSION

The clinical significance of these anomalies seems not much different from that of double ureters. In 5 cases (38 per cent) the condition was present without clinical manifestation. But there is an increased risk of obstructive hydro-ureter (3 cases) possibly leading to infection (3 cases), and pyonephrosis (2 cases). However, even if two badly infected ureters are found clinically, there remains the unexpected possibility, however remote, that a third and healthy may be found draining healthy renal tissue on the same side, as occurred in this new case. There is also an increased predisposition to stone formation (2 cases), and the tendency to association with other congenital abnormalities (3 cases), such as ectopic renal tissue (1 case), aberrant renal vessels (1 case), ectopic ureteric orifice (1 case), and these may all cause trouble.

The embryological significance I cannot fully assess. The theory that separate ureteric buds can arise independently from the primitive Wolffian duct seems to be supported by the existence of three ureteric orifices on one side of the bladder. The theory that complete double ureters may be formed simply by fission however early, of one ureteric bud seems to be supported by finding (1) two ureters enclosed throughout their course in a common fibrous sheath (the third being separate), (2) two renal pelves lying side by side with each other as well as one above the other in the same kidney. This supports the present general opinion that either or both of these embryological faults may take part in the formation of ureteral anomalies.

It is a pleasure to record my thanks to Mr T Twistington Higgins, OBE, for permission and encouragement to publish this case, to the librarians of the Royal Society of Medicine and the British Medical Association for help with references, and to Mr Alleyoyne, of the Photographic Department, Hospital for Sick Children, for his photographs.

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## THE SURGICAL ANATOMY OF THE PAROTID GLAND

By FRANK R. HURFORD

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THE low incidence of facial paralysis following operation for parotid tumour was emphasized by Hamilton Bailey (1941), who reported 6 cases, in 5 of which the nerve escaped completely. More recently in a personal communication he records a series of over 30 complete or partial parotidectomies with only 2 cases of nerve damage. To account for these successes he cites the operative appearance of the gland, which in nearly all cases showed a large superficial lobe and a smaller deep lobe connected by an isthmus. Above and below the latter the primary divisions of the facial nerve could be

McWhorter (1917) confirmed the bi-lobed nature of the gland, but found the connecting isthmus was situated not superiorly, but centrally, being embraced above and below by the temporofacial and cervicofacial branches of the nerve. This is in keeping with Hamilton Bailey's observations at operation, but is incompatible with Gregoire's theory concerning the origin of the deep lobe. More recently, McCormack, Cauldwell, and Anson (1945) have confirmed the existence of a centrally placed isthmus with branches of the facial nerve above and below it, but their report concentrates mainly on

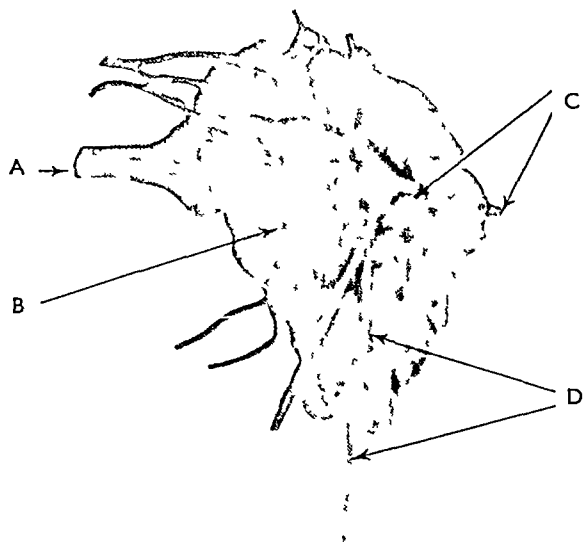


FIG 253—Medial aspect of parotid showing small deep lobe. Note that the trunk of the facial nerve is at first embedded in the substance of the superficial lobe, while the cervical branch also pierces the gland substance inferiorly. A, Parotid duct, B, Deep lobe, C, Trunk of nerve piercing superficial lobe, D, Cervical branch piercing superficial lobe.

seen running forward in the plane between the lobes. It was possible to remove the superficial lobe without disturbing the nerve in any way, and, when necessary, the deep lobe could also be extirpated by retracting the cervicofacial and temporofacial divisions of the nerve and extracting the gland tissue between them. On account of these observations, Hamilton Bailey suggests a revision of the standard anatomical descriptions of the gland, which make no mention of the bi-lobed nature of the organ.

As far back as 1912 Gregoire showed that the parotid was divisible into superficial and deep lobes separated by the branches of the facial nerve. He stated that the two lobes were united above the nerve. Observing that there was no deep lobe in the three-months' foetus, he suggested that upward extension of the gland was halted on reaching the base of the skull and that further growth resulted in an inward and then downward deflection of the gland, with consequent production of a deep lobe.

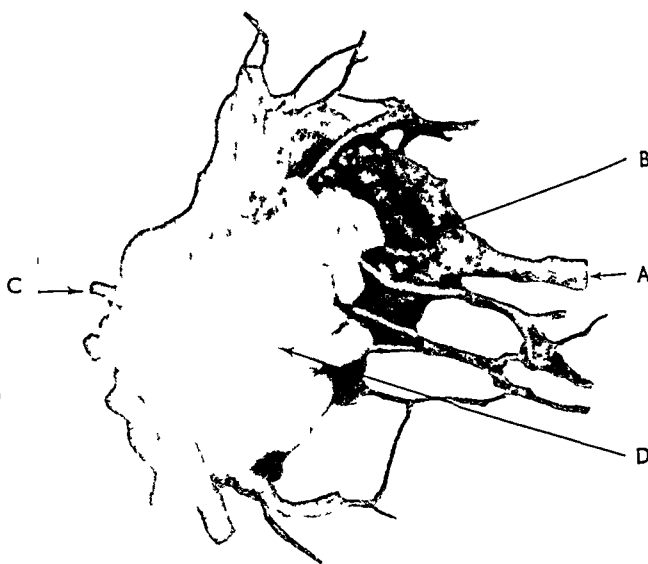


FIG 254—Lateral aspect of parotid, showing small superficial lobe and large deep lobe. A, Parotid duct, B, Deep lobe, C, Trunk of facial nerve, D, Superficial lobe.

the variety of patterns formed by the terminal branches of the facial nerve.

The present series of eleven normal adult parotid glands were dissected to ascertain whether the bi-lobed nature of the organ was sufficiently well defined to permit of partial or total parotidectomy without nerve damage, in other words, to determine whether the normal anatomical lobes are comparable with those apparently discernible at operation on the diseased organ.

## FINDINGS

In 10 of the 11 specimens there was evidence of division into superficial and deep lobes. In 7 of these the isthmus was clearly defined, being narrow in 6 and broad in 1, in the remaining 3 it was ill defined and its position inconsistent. In all 10 specimens tedious and careful dissection was required to demonstrate the isthmus. Of the 10 bi-lobed parotids there were only 4 in which all the branches of the facial nerve remained strictly in the plane

between the lobes. In 5 one or more branches of the nerve pierced the deep lobe and in 1 some of the branches traversed part of the superficial lobe (Fig 253). Moreover, in 3 specimens the trunk of the facial nerve before division lay not between the lobes, but in the substance of one or other lobe (Fig 253). Finally, in 5 parotids the deep lobe was found to be larger than the superficial one (Fig 254).

### DISCUSSION

Contrary to Bailey's findings in the diseased parotid, the above observations show that it is often difficult to define the two lobes of the normal gland. Furthermore, when they have been identified, the branches of the facial nerve are not always confined to the interlobar plane, nor does the nerve-trunk invariably enter between the lobes. Definition of the two lobes would probably be easier in the living subject than in the formalin-preserved cadaver, but deviations of the nerve-trunk or some of its branches from the interlobar plane would still be encountered. In view of the highly successful operative results reported by Bailey, one is forced to the conclusion that the lobes encountered surgically are probably not strictly comparable with those of the normal gland. An encapsulated tumour growing in the superficial lobe would tend to thin out and compress the surrounding normal gland tissue and displace the nerve medially. Moreover,

the size of the tumour compared with the uninvolved deep part of the gland might give the impression of a more well-marked isthmus than actually exists normally.

McWhorter (1917) and Bailey (1941) both refer to the smaller size of the deep lobe, and the latter author implies that superficial lobectomy alone adequately removes most neoplasms. However, in nearly half of the present series the deep lobe was the larger part of the gland and its removal without damaging the facial nerve would be a most difficult procedure and probably impossible in the presence of a tumour. In view of Bailey's successes it would appear, therefore, that the deep lobe is less liable to neoplastic change. There is, however, no obvious difference in the microscopical appearance of the normal lobes.

I wish to thank Professor T. Nicol for help and advice in preparing this paper and also Mr. Hamilton Bailey, whose personal communication to Professor Nicol led to the investigation.

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## SIMPLE PAPILLOMA OF THE URETER

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"PRIMARY tumours of the ureter are exceptionally rare" (Illingworth and Dick, 1941). Similar statements can be found in other text-books, and afford justification for recording even single cases. According to Moore (1942), whose review is the latest in the English literature, the first case of benign tumour of the ureter was published in 1861 by Lebert. The first account of a malignant neoplasm appears to be that of Rayer (1841), while Davy (1884) was the first to describe the condition in the English literature. There are less than 60 cases of benign tumour reported in the literature. Johnson and Smith (1942) brought the number up to 53, Moore (1942), and McMahon (1944), each reported 1 case, and Barnes and Kawaichi (1944) recorded 2 examples. Malignant tumours, while rare, are commoner than benign ones. Counsellor, Cook, and Seefeld (1944) found 191 reported cases.

Benign tumours of the ureter occur on either side, and at any age, but are commoner in the fifth and sixth decades. They are commoner in men than in women, and appear in the lower portion

of the ureter more often than in the upper. Usually they are papillomatous, closely resembling the much commoner papilloma of the urinary bladder. A few, such as those reported by Melico and Ford (1932) and Johnson and Smith (1942), are polypoid connective-tissue tumours. The papillary tumours may be single or multiple, are usually small, red or grey, soft, with a shiny surface, they arise from a distinct pedicle and are commonly villous. The ureter usually shows a fusiform dilatation at, and a little above, the level of the tumour. The presenting symptoms and signs in order of frequency are hæmaturia, pain, and renal enlargement. Diagnosis cannot be made without the aid of ureteric examinations, including intravenous and retrograde pyelography.

Nothing is known about the aetiology of these tumours, although Johnson and Smith (1942) thought that the polyps in their case were congenital, and Müller (1940) recorded a benign papilloma in a man of 42, who from the age of 18 to 26 handled benzidine in his work. Calculi are

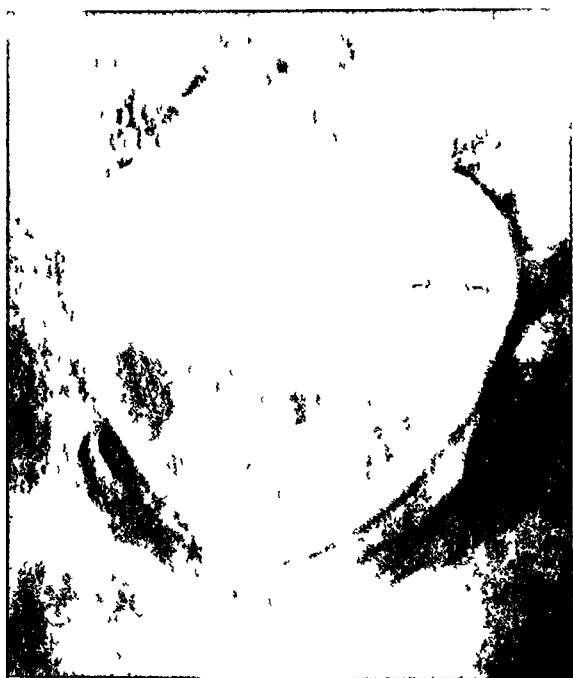


FIG 255—Intravenous pyelogram, positive print. Arrows indicate filling defect at lower end of left ureter



FIG 256—Photograph of specimen (Reduced)



FIG 257—Photograph of ureter and tumour (Natural size)



FIG 258—Photomicrograph of papilloma, stained H and E ( $\times 90$ )

their patient it is very doubtful, however, whether calculi are ever anything but incidental or secondary to the tumour

### CASE REPORT

Mrs B, aged 42 years, was referred to one of us (H B Y) by her doctor because of two recent painless attacks of hæmaturia. She had not experienced frequency, dysuria, or backache. Her blood-pressure was

present in a little over 10 per cent of cases, and Melico and Ford (1942) considered they played a causative role in the production of the tumour in

normal, and no evidence was found of any constitutional disability likely to produce hæmaturia. There was neither renal tumour nor tenderness. On cystoscopy a little blood was seen coming with the urine from the left ureteric orifice. Indigocarmine injected intravenously appeared from the right ureter in  $4\frac{1}{2}$  minutes, from the left it appeared in 6 minutes and the urine was purple instead of blue. A ureteric catheter was passed up the left ureter to the kidney pelvis, and, unexpectedly, no blood was found in the urine coming down the catheter. It was at first considered that there were two ureters on the left side and that the catheter had passed into the one not discharging blood.

A plain radiographic examination did not reveal any abnormality of the urinary tract nor any evidence of urinary calculus. Intravenous pyelography was undertaken and five minutes after the injection of the drug, normally functioning kidneys were seen, with no signs of hydronephrosis or other abnormality. The ureters were not clearly outlined. Firm pressure was then applied to the lower abdomen and further radiographs taken thirty minutes later revealed the ureters. The lower end of the left ureter ended abruptly in a sharp concave extremity at a point about 2 in. above the ureteric orifice. The shadow of the drug-laden urine was seen embracing a clear, semicircular area (Fig 255). The appearances suggested either a papilloma or else a urate stone, which, in its pure state, is only slightly radio-opaque and cannot be demonstrated in a plain radiograph.

It was remembered that a slight arrest of the catheter had been felt about an inch up the ureter, and it was now evident that the bleeding must be coming from the lower end of the ureter and not from the kidney.

OPERATION was performed on June 28, 1945, under spinal anaesthesia plus gas and oxygen. The left ureter was exposed extraperitoneally and followed down to the bladder; this was made difficult by adhesions from a previous hysterectomy. The ureter was divided below a fusiform dilatation just above the bladder; the kidney was then exposed in the loin and removed with the ureter. The patient made a good recovery, and has had no further urinary trouble.

THE SPECIMEN (Fig 256) consists of the left kidney and ureter. The kidney appears quite normal, its pelvis

is of normal size or very slightly dilated. The ureter shows a normal smooth mucosa and no thickening of the muscle; at the lower end is a villous papillary tumour (Fig 257) arising from the mucosa by a single narrow stalk. The villi are slightly pink, moderately opaque, and have a shining surface. The ureter is somewhat dilated at the level of the stalk of the tumour and for half an inch below this. Histological preparations (Fig 258) show a papilloma with many villous processes of transitional epithelium covering a core of delicate connective tissue and capillaries with a few inflammatory cells. There is no suggestion of malignancy.

### SUMMARY

A case is described of a benign papilloma of the ureter in a woman aged 42 years. Such tumours are even less common than the rare carcinomata of the ureter.

The photographs were taken by Mr A W Collins, F.I.M.L.T.

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## CYSTOSCOPY IN THE DIAGNOSIS AND TREATMENT OF BILHARZIA HÆMATOBIUM INFECTION

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THE subject of bilharzia is of general interest now that many men in the Forces, who have served in East Africa and other tropical countries where such infection occurs, have returned home to Britain and the United States. Undoubtedly the appearances discussed below will be seen from time to time during cystoscopy in temperate climates and will cause some degree of difficulty in diagnosis to those who are not familiar with them.

In many cases a certain diagnosis and adequate treatment in *Bilharzia hæmatobium* infection necessitate the co-operation of physician and surgeon, or at any rate the employment of both medical and surgical procedures. Three years' experience in the Giriama Reserve, outside Mombasa, has forced me to the conclusion that to rely entirely on microscopical examination of the urine for bilharzia ova for the diagnosis of this condition is in many cases

a delusion, and that it is fallacious to rely on the test of three negative urine examinations, after giving 24 gr. of antimony tartrate in a month, in deciding that the treatment has been adequate. I am convinced that cystoscopy is essential both to clinch the diagnosis and to assess the efficiency of the treatment given, and have tried to carry this out in as many cases as possible during the last two years on the coast of Kenya.

Some may think that the diagnosis of this disease by the use of the cystoscope requires an expert. In a sense that is true, but it takes very little time to become sufficiently acquainted with the signs of the disease to make a diagnosis even in early cases and to gauge the effect of treatment by comparing the picture seen before and after; this is especially so in areas where the disease is common. In examining the first few cases I was only able to record



what I saw without understanding the significance of my findings, but even after 10 to 15 cases the method was proving of definite assistance in the diagnosis of cases with a negative urine and in the differential diagnosis from other diseases of the bladder.

As far as is known, the effects of this disease are seen mainly in the bladder and to a lesser extent in the lower ureter and in the urethra. The *Bilharzia hæmatobium* worms live in the veins of the portal system, the female being considerably smaller than the male and living in a groove in the ventral surface of the male. When the female is ready to lay her eggs the worms migrate together against the venous blood-stream as far as they are able, the female then leaves the gynæcophoric canal of the male and travels still farther distally, when she has travelled as far distally as possible into the smaller venules she lays her eggs, the spines of which stick into the walls of the veins, thus preventing the blood-stream from sweeping them back towards the liver. In the majority of cases the worms reach first the hæmorrhoidal veins and then pass on to the veins around the lower ends of the ureters and those of the urinary bladder, prostate, and urethra, sometimes they pass on to other pelvic and perineal veins that anastomose with the hæmorrhoidals. Instinct seems to guide the worms to reach venules from where the eggs may easily reach the bladder and be voided in the urine. Thus it is that the earliest and most certain diagnosis of the condition can be made by examination of the bladder and that the effect of treatment can best be seen in this organ. Bilharziasis of the seminal vesicles, spermatic cord, epididymis, testes, and tunicae vaginales is, I believe, commonly found in areas where this infection is prevalent, but even so the diagnosis is made much more simply by examination of the bladder. Even where other organs are affected, in nearly all cases the bladder is affected as well. In a few cases instinct seems to mislead the worms to pass from the portal veins to veins of the systemic system, this accounts for the fact that bilharzia, like syphilis, can produce symptoms in all the systems and mimic a great many other diseases. Bilharzia ova have been found at autopsy in nearly every organ of the body, but this does not alter the fact that the earliest and simplest method of diagnosis is made by cystoscopy.

Any one working in the Kenya Highlands, and I believe in Kavirondo where intestinal bilharzia is much more common, may well wonder whether a relatively elaborate method of diagnosis and of assessing treatment is warranted for a disease that is found, as it were, sporadically only. But in the Coast Province, especially in the native reserves near Mombasa, the disease is extremely common. In this area there are at least four native hospitals concerned. At a conservative estimate 90 per cent of the Wagirama have been or are infected. Of 97 healthy Giriama schoolboys who were examined microscopically once only, 75 were found to have ova in the urine. Of 1500 out-patients examined once only at Kaloleni Hospital in 1943, 700 were found to have ova in the urine. Of these many more would have given a positive finding if examined repeatedly and many others would have shown stigmata at cystoscopy. There is no doubt in my

mind that this disease, which leads to chronic anæmia, chronic cystitis, hydronephrosis, vesical calculus, vesical carcinoma, hepatomegaly, and splenomegaly, is to a very large extent responsible for the poor health and gross lack of initiative found amongst the Wagirama. This is not only a problem of diagnosis and efficient treatment, but as much, if not more, of preventive medicine. When the water supply in the Giriama Reserve is improved and the people are instructed not to urinate into it we may expect *Bilharzia hæmatobium* to be much less common and the average health of the Wagirama much improved. Even so, for years after the advent of adequate preventive medicine, we shall have many chronic cases to deal with, presenting greater difficulties in diagnosis and treatment than the relatively straightforward acute cases. If with the course of time the process of detribalization continues and African industries grow up in the larger towns, we may expect to be presented with these subacute and chronic cases in increasing numbers all over the country. For these reasons I believe that we shall need, in this Colony, more precise methods of diagnosis and more carefully controlled treatment than has been employed in the past.

Cystoscopy is not universally used in the various countries where the disease is prevalent. So far as I can ascertain it has not been employed in East Africa apart from work done by medical officers in the military hospitals during the last two or three years. In South Africa Cawston (1945) deprecates the employment of cystoscopy and believes that repeated examination of the last drops of urine will always give a positive finding in bilharzia infections. He has worked in Durban for many years and been closely associated with the treatment and prevention of this disease. Campbell Begg (1944), of Johannesburg, states his belief that "ova are so seldom seen in the urine in cases of chronic bilharzia that their absence has no diagnostic significance. The only reliable method of diagnosing the disease is by cystoscopy." In Egypt I believe that all the larger hospitals employ this method, which is strongly recommended by Makar (1932), Professor of Surgery in Cairo University. In a report on one case of a young European who had been resident in South Africa, Christopherson and Ogier Ward (1934) describe the diagnosis and treatment. The treatment was controlled by cystoscopy performed before commencing the injections and one month after the last injection.

**Cystoscopic Appearances**—The cystoscopic picture of bilharziasis of the vesical mucous membrane is characteristic. The mucosa is affected in the vast majority of cases. In cases where it is normal, changes in the muscle wall leading to fibrosis and calcification of the ova can often be detected by a straight radiograph of the bladder, as has been demonstrated by two workers in a hospital at Alexandria (Harlow, 1930). A bladder that can be felt per abdomen as a hard mass is, in my opinion, always carcinomatous and never merely a fibrosed and hypertrophied bilharzial bladder.

1. **Hyperæmia**—The mucosal vessels become dilated, especially around the ureteric orifices, which are often surrounded by an area of oedema. This is the earliest change, but it is not specific.

2 *Tubercles*—These are mostly found in the trigone or around the orifices, but may be seen anywhere, pale in colour, surrounded by a zone of hyperæmia, they vary in size from that of milary tubercles to a good deal larger (Fig 259)



FIG 259—Case of bilharzial cystitis showing numerous tubercles around the left ureteric orifice, a small hæmorrhage above, and a group of dilated veins below

cystoscopic examination are slightly larger than, but otherwise similar to, the tubercles seen in tuberculosis. These tubercles are formed of proliferating epithelial cells of the mucous membrane, in the midst of which may be found a few ova, and this change is presumably due to the irritation of the ova or their toxins. The presence of the characteristic tubercles is pathognomonic of bilharzial infection, in many cases they may be seen when repeated examination of the last few drops of urine to be passed has been negative. Only when the ova have ulcerated through the mucosa do we find them in the urine. In many of these cases there are visible shallow ulcers with a dark base due to coating with altered blood. The afore-mentioned changes occur most commonly in the trigone and around the ureteric orifices. In a few cases no changes are seen at the first examination beyond slight cedema around the orifices, with considerable injection around them and over the trigone. The characteristic symptom of pain at the tip of penis during micturition is present, presumably due to irritation of the trigone musculature by ova. In this case when ova are not present in the urine, examination will sooner or later reveal the presence of the characteristic bilharzial tubercles. In another small group of cases the tubercles may be seen though there are no symptoms relegated to the bladder.

*Case 1*—S G, male Giriama, aged 30. First seen in August, 1942, he had been treated one year previously for hæmaturia and pyuria of uncertain origin with sulphapyridine and antimony tartrate. On admission he complained of burning pain in the urethra during micturition. No gonococci or ova were found on repeated examination of the urine. Cystoscopy revealed only a little mucus all over the bladder, a few scattered blood-clots, and slight injection over the trigone. Cystoscopy one month later showed a few areas of hæmorrhage and a few small ulcers. Cystoscopy three months later showed only a few clots of blood on the bladder wall, he was then given a course of combined antimony tartrate and founadin. He came back to hospital in 1944 complaining of burning pain during micturition and occasional hæmaturia. The urine was still negative. Cystoscopy revealed the presence of groups of transparent cysts and a few characteristic tubercles. He asserted that he had followed the prophylactic regime against contraction of this disease since the time of his first coming to hospital. Therefore, presumably, the first course of treatment was inadequate, definite tubercles were seen for the first time only two years after contracting the disease.

*Case 2*—J K, male Giriama, aged 55. Admitted to hospital in April, 1944, with a large swelling in the left loin. There were no symptoms referable to bladder or urethra, and there was no hæmaturia. Cystoscopy was performed in order to confirm that the tumour was renal in origin. The characteristic tubercles of bilharzia were seen around the orifices and in the fundus. The absence of symptoms, therefore, coincided with absence of trigonal irritation. On removal the tumour was proved to be a hypernephroma.

2 *Other Conditions may resemble Bilharzia Infection or may be Concomitant with it*—The characteristic symptoms of vesical bilharziasis—pain during micturition, frequency, hæmaturia, and strangury—are common to a number of other diseases (Allen, 1936). For this reason it is advisable when ova are not discoverable in the urine

3 *Closely-set Tubercles*—These give the appearance of heaped-up granulations, often partly covered by blood-clot.

4 *Granulomatous Polypoid Growths*—These are often found together with granulations, they have a broad base and are slightly lobulated and have an irregular knobby appearance.

5 *Bullous Cysts*—These are pale colourless cysts twice the size of tubercles, sometimes they are solitary and sometimes found in clusters, they are due to epithelial hyperplasia which blocks the openings of the submucous glands and are akin to the Nabothian follicles found in chronic cervicitis. Sometimes these cysts are the only sign of bilharzial cystitis.

6 *Ulcers*—These are usually shallow and small, but when secondarily infected may resemble an early carcinoma, they may be differentiated by watching the effect of antimony treatment.

7 *Chronic Bilharzial Cystitis*—The mucosa is covered by a layer of thick mucus, giving a blurred and hazy appearance, in the mucus are suspended numerous glistening white pinhead calcareous particles.

We can now consider in greater detail specific types of case in which cystoscopy is of value in diagnosis and treatment.

## DIAGNOSIS

1 *No Ova found in the Urine*—In many cases of bilharziasis there are gross changes in the bladder wall and submucosa where no ova are being voided in the urine. The ova pass from the venule supplying the bladder into the muscle coats and submucous layer. Here they may become encysted and surrounded by fibrous tissue, and calcification occurs in some cases. Others in the submucous layer cause the formation of bilharzial tubercles which on

to cystoscope the patient in order to exclude the presence of some other disease. On the other hand, the presence in this hospital of numerous bladder scoops and stone-holding forceps which were passed on from the old hospital in Mombasa after the last war show that many cases of bilharzial cystitis were diagnosed as vesical calculus.

**Case 3**—K M, male Giriama, aged 40. Treated 1½ years previously for bilharzial cystitis, he now complains of frequency, burning pain during micturition, and pyuria, with attacks of strangury. Cystoscopy revealed the presence of a large calculus, the ureteric orifices were dilated to about ten times the normal size. There was marked trabeculation and two or three diverticula were present. This man died from uræmia when he might well have recovered had he been treated for the calculus when he first came to hospital.

**Case 4**—B K, male Giriama, aged 45. He was admitted to hospital complaining of suprapubic pain, frequency, and dysuria. The bladder was enlarged to 3 in above the pubes and its wall was thick and hard, no ova were found in the urine. At operation the bladder was full of papillomatous new growth which on section proved to be carcinomatous. Clinically this was a typical case of long-standing bilharziasis with superadded chronic cystitis.

**3 It is necessary to be on the look out for Sequelæ**—Cases of recent bilharzial infection are unlikely to show sequelæ, but other diseases of the bladder may be present at the same time, most long-standing cases of bilharziasis show sequelæ, as, for instance, polyps, papillomata, and carcinomata resulting from long-continued action of bilharzial prostatitis. For these reasons it is highly desirable that cystoscopy should be undertaken before the commencement of treatment, even when microscopy reveals the presence of ova in the urine (Makar, 1935).

**Case 5**—K M, male Giriama, aged 25. He was admitted with five months' history of hæmaturia, pain on micturition, and pain over the bladder. Examination of the urine showed the presence of ova, pus cells, and red blood-cells. Cystoscopy revealed the presence of a large irregular faceted calculus, covered with altered blood and a concomitant bilharzial cystitis with ulcers and tubercles.

**Case 6**—N K, male Giriama, aged 50. He was admitted to hospital with a right inguinal hernia. On examination the urine was found to be blood-stained, on rectal examination the prostate was considerably enlarged, ova were found in the urine. At cystoscopy there was intravesical enlargement of the prostate and a mild bilharzial cystitis as evidenced by the presence of the characteristic tubercles and slight injection of the trigone.

**4 Often it is necessary to investigate the Ureters and the Renal Function**—Bilharziasis can affect any part of the bladder, but the trigone and area around the ureteric orifices are most commonly affected. The lower end of the ureter for one or two inches above the bladder is quite commonly diseased. The kidney and upper ureter are only secondarily affected as the result of prolonged back pressure and chronic infection.

In cases which present with attacks of renal colic, catheters should be passed along the ureters

to demonstrate the presence or absence of obstruction in their lower ends. Where laboratory facilities are not available the renal function may be estimated by intravenous injection of indigocarmine, which is ejected from the orifices in seven to ten minutes when the renal function is good. Where X rays are not available the capacity of the renal pelvis can be estimated by injecting dilute mercury oxycyanide solution up the catheter until slight pain is felt in the loin.

**Case 7**—C K, male Giriama, aged 40. He was admitted with a two months' history of dysuria and strangury. No ova were found in the urine, he developed an attack of renal colic whilst in hospital. Cystoscopy revealed a slightly pointing left ureteric orifice with injection of the trigone and petechial hæmorrhages. The catheter only passed 1½ in up the left ureter, no indigocarmine was seen emerging from the left ureter, though it emerged from the right in ten minutes. Intravenous pyelography showed a block 1½ in above the bladder in the left ureter. At operation 1 in of thick stenosed ureter was removed from just above the bladder and the ureter transplanted into the bladder slightly higher up. Section showed that the removed portion of ureter was bilharzial.

## TREATMENT

**1** The efficient and successful treatment of *Bilharzia hæmatobium* infection is by no means as simple a matter as might be thought at first sight. The concentration of antimony tartrate required to kill the worms is not far short of that which proves severely toxic to the patient. Egyptian workers state that one case in two thousand dies from the toxic effects of this drug. Most of the cases treated in the Giriama Reserve were given 25 gr of the drug within a period of four weeks, and nearly all of these showed toxic symptoms well before the end of the course. Valuable data can be gained as to the efficiency of treatment by comparison of the cystoscopic appearances before treatment with those two weeks after the completion of a course of treatment, where the treatment has been adequate cystoscopy will show marked improvement in any concomitant acute cystitis and marked retrogression of granulomatous polyps and bilharzial tubercles. It is recommended that the patient should return after three months and again after six months for examination, and if he still has symptoms or abnormal constituents in the urine, such as red cells or pus cells, he should be cystoscoped again. If ulcers, granulomata, or tubercles are present, or if there is a cystic cystitis, a further course of treatment should be given.

**Case 8**—C M, male Giriama, aged 20. He was admitted with a history of three months' hæmaturia and pain during micturition, many ova were found in the urine. Cystoscopy revealed numerous small ulcers and large blood-clots. The left ureteric orifice was slit-like and surrounded by pale grey nodular growth covered with mucus, in which were suspended numerous small calcareous particles. The right orifice was completely obscured by polypoid granulomata, which were covered with typical tubercles. One month later, after treatment, cystoscopy showed that the growth surrounding the right orifice was reduced in size by one-third. The granulomata obscuring the left orifice were reduced in size by three-quarters, no ulcers were seen, there were only scanty tubercles and the concomitant acute cystitis had subsided. The patient was symptom free.

*Case 9*—M K, male Giriama, aged 30. He was first seen in July, 1942, complaining of hæmaturia of many years' duration. Bilharzia ova were found in the urine. At cystoscopy an acute cystitis was revealed, the mucosa being bright red. The ureteric orifices were hidden by a large bright-red cauliflower mass (*Fig 260*). He was given a course of antimony tartrate and foudadin. On March 2, 1943, he was symptom free. Cystoscopy showed a smooth undulating swelling of the whole of the trigone and ureteric bar, resembling hills and valleys. Both orifices were slit-like. There was a small sessile

bladder, with calcareous particles suspended in it, at repeated routine cystoscopy. In *Case 8* it was not possible to exclude bilharzial carcinoma until after the course of treatment, when the second cystoscopy showed marked retrogression of the granulo-matous and polypoid growths. In *Case 9* the cystoscopy carried out before treatment revealed signs that were very suspicious of carcinoma. This possibility was only ruled out when the second cystoscopy showed marked retrogression of the

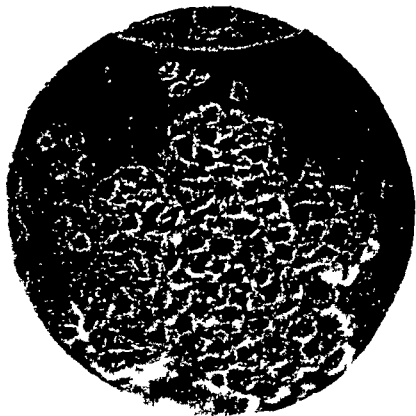


FIG 260—*Case 9* Showing large papillomatous bilharzial polyp in bladder (Before treatment)

granular tumour immediately below the left orifice and a smaller but similar tumour a little above it, the whole mucosa was covered by a thin layer of mucus in which were suspended numerous small calcareous particles, no signs of active bilharziasis were seen.

On May 29, 1944, he was still symptom free and reported for routine cystoscopy. This showed a pale yellow mucosa covered with mucus in which were suspended calcareous particles as before. There were no signs of active bilharzia, the hill-and-valley appearance was much reduced, the orifices were still slit-like, and no signs of the previous granulomata could be detected (*Fig 261*).

2 As pointed out by Makar (1942), the bilharzial toxins in the bladder wall, acting over a period of years, frequently lead to a carcinomatous change. To be at all effective, treatment must be undertaken as soon as possible after this change has set in. In the past three years I have seen at least six cases with a history of chronic bilharzia which came to hospital only when the bladders were full of masses of carcinomatous tissue, secondary invasion was widespread in all these cases. If seen at an earlier stage they might have been cured by transplantation of the ureters, followed by total cystectomy. The conclusion to be drawn is that routine cystoscopy should be performed at six-monthly intervals in all cases where there is permanent damage to the bladder wall or mucosa, as a result of bilharzia infection, in order that any carcinomatous change should be detected as soon as possible. Calcification in the bladder wall may be detected by X-ray examination. Permanent changes in the mucosa are evidenced by the finding of a covering of mucus all over the

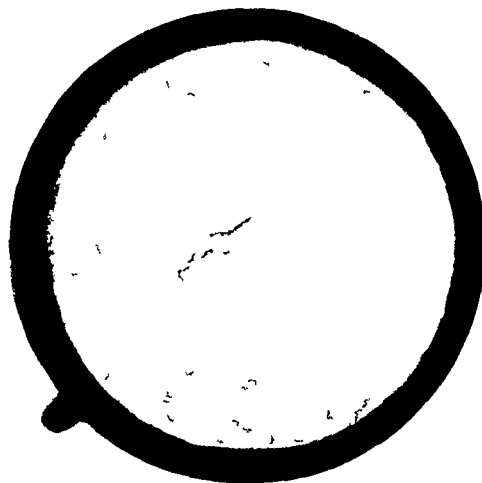


FIG 261—*Case 9* After treatment there is no vestige of the polyp. The mucosa is covered with mucus, in which are suspended numerous calcareous particles.

granulomata. The mucous and calcareous particles found to persist in a symptom-free patient two years later show that there was permanent damage to the mucosa, resulting in a chronic catarrhal state. This is the type of patient who should be cystoscoped at intervals of six months in view of the possibility of malignant change.

### SEQUELÆ

The sequelæ of this disease present either more or less complicated problems in urogenital surgery. At present in the Giriama Reserve they are often seen.

1 **Chronic Cystitis**—We have already discussed this condition.

2 **Calculus Formation**—The calculi are mostly of calcium phosphate, they may be large or small, single, or multiple, and contain calcified ova.

3 **Changes around the Ureteric Orifices**—Dilatation, scarring, obstruction, and hypertrophy all occur. These are among the most interesting changes seen in bilharziasis and have a great number of individual characteristics.

4 **Hypertrophy of the Bladder Musculature**—This leads to hydronephrosis and the usual accompanying renal changes. Renal failure would seem to be long delayed.

5 **Renal Colic**—This is due to ureteral obstruction at the orifice or slightly above it.

6 **Carcinoma**—This may assume various forms, it is more rapidly progressive than most non-bilharzial types. In Egypt bilharzial cancer is much more common than the non-bilharzial. There

seems little doubt that this type is due to the previous long-standing bilharzia infection, it has been ascribed to (a) long-standing sepsis, (b) mechanical irritation, and (c) prolonged action of toxins from the ova (Makar, 1942)

### SUMMARY

1 Routine use of the cystoscope in both the diagnosis and treatment of bilharzial cystitis is advocated

2 The typical appearances at cystoscopy are described

3 A number of individual cases are presented, indicating in detail where cystoscopy can help in avoiding the difficulties of early and differential diagnosis and in assessing the efficacy of treatment

4 The common sequelæ of this condition are enumerated and described briefly

My thanks are due to the Hon Director of Medical Services for permission to publish this paper

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## THYROTOXICOSIS AS A SURGICAL PROBLEM

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THE recent introduction of thiourea and thiouracil as therapeutic agents in thyrotoxicosis caused many physicians to believe that these compounds would displace surgery. Despite early optimistic reports on the efficacy of thiouracil, certain types of thyrotoxicosis appeared to remain essentially a surgical problem. These included thyrotoxicosis associated with heart failure, the more serious types of cardiac arrhythmias, a large goitre, and marked exophthalmos. As experience with these drugs has grown, there has been a tendency to view with less optimism their curative properties. This in a large degree has been due to their toxic properties, including such reactions as agranulocytosis, fever, dermatitis, jaundice, oedema, arthritis, purpura, lymphadenopathy, cardiac arrhythmia, and even an exacerbation of the thyrotoxicosis. Further, it is by no means clear that, in the large majority of cases, thiouracil can be discontinued without a recurrence of the symptoms of thyrotoxicosis. At the best, therefore, the thiouracil medication in thyrotoxicosis is not unlike the insulin therapy of diabetes—in each case the disease is controlled, not cured. Surgery, therefore, has certain advantages in that a cure of the thyrotoxicosis can be established quickly, after which no further controlled observations on the patient are necessary. It is probable that many patients with diabetes would prefer a surgical cure to insulin therapy. In discussions on the various methods of treating thyrotoxicosis, the chief criticism against surgery is its operative mortality. Until 1923 the operative mortality was sufficiently high, except among especially skilled surgeons, to make operation a hazardous procedure. In 1923 the action of iodine in thyrotoxicosis became more clearly understood as a result of observation on the basal metabolism. The operative mortality of the leading thyroid surgeons fell below 1 per cent, and operations for the relief of thyrotoxicosis were now attempted not without success by less experienced thyroid surgeons. Paradoxically there was a tendency for a rise in the

mortality from operations for thyrotoxicosis in later years, but this was doubtless due to operations on patients who, before this, would have been too ill to withstand surgery.

In the paper which follows, which is based on a study of the last sixteen years, an attempt is made to follow in detail the effects of iodine on the basal metabolism in thyrotoxicosis, the value of iodine before and after subtotal thyroidectomy, the post-operative reaction, and the early assessment of a successful thyroid operation.

### I IODINE AND IODIDE DOSAGE IN THYROTOXICOSIS, AND ITS EFFECT ON THE BASAL METABOLISM AS A GUIDE TO OPERATION

#### HISTORICAL

**Iodine Administration**—In 1813 Courtois discovered iodine. Prout (1834) maintained that in 1816 he successfully used an iodine compound in the treatment of goitre and that his remedy was adopted three years later by Dr Elliotson of St Thomas's Hospital. Prout did not publish these findings until 1834, by which time Coindet (1820) had already drawn attention to the value of iodine in simple and probably in toxic goitre. The credit, however, must go to Trousseau (1868) for describing clearly not only that iodine could bring about an artificial remission in the course of thyrotoxicosis, but also that the beneficial effects of iodine medication quickly passed off as soon as the drug was stopped. Trousseau's exact words are worth recording —

In the course of October, 1863, I was consulted by a young married lady who habitually resides in Paris. She was suffering from a subacute exophthalmic goitre. The bronchocoele was of great size. When I examined her for the first time, although I had let her rest for a long while and although I repeated the examination several times and at sufficiently distant intervals, so as to make

sure that she was no longer under the influence of emotion, I still found that her heart-beat was at the rate of 140-150 times in the minute. I recommended hydropathy and I wished to administer at the same time tincture of digitalis, but, preoccupied with the idea that there would be some danger in giving iodine, I wrote iodine instead of digitalis, so that the patient took some 15-20 drops of tincture of iodine a day for a fortnight. When she came back to see me her pulse was 90. I found out my mistake and I substituted tincture of digitalis for that of iodine, but after another fortnight the pulse had again gone up to 150, so that I at once returned to the iodine.

Notwithstanding these exceptional cases, however, bear in mind that iodine generally does harm in Graves' disease.

Later Cheadle (1869), Ohleman (1911), Marine and Lenhart (1911), and Waller (1914) confirmed Trousseau's observations, but the influence of Kocher and his school (1910, a, b), with their grave warning of the dangers of an iodine-precipitated thyrotoxicosis, dissuaded most clinicians from employing iodine therapeutically for the next ten to fifteen years. By 1920, when more simple forms of apparatus became available, measurement of the basal metabolism was being carried out more frequently, and at or about that time a series of publications appeared on the effects of iodine and its compounds in thyrotoxicosis, including studies of the basal metabolism. These were contributed by Neisser (1920), Loewy and Zondek (1921), Jagić and Spengler (1924), Cowell and Mellanby (1924), Starr, Walcott, Segall, and Means (1924), and Plummer and Boothby (1924). The greatest credit, however, must be given to Plummer and Boothby, for they clearly demonstrated the beneficial effects of iodine as a pre-operative measure. It is interesting to note that Plummer, in his first communication on this subject (1923), advised the administration of compound tincture of iodine *for ten days after operations on the thyroid*. Later, with Boothby (1924), he stated the properties of iodine more clearly. They pointed out that in thyrotoxicosis the maximum improvement usually occurred after iodine, in adequate doses of at least 10 min daily, had been taken for eight to ten days. They also drew attention to the fact that the maximum improvement might be delayed for two or even three weeks. They therefore recommended that any operation on the thyroid should be postponed until it was established that no further improvement could be obtained from the iodine. Such a procedure brought about a fall in the mortality-rate of thyroidectomy for the relief of thyrotoxicosis to less than 1 per cent at the Mayo Clinic.

**The Common Action of Iodine and Its Compounds**—It is not clear how iodine exerts its action on the thyroid gland, but it has been established that not only free iodine but all its compounds are alike in producing clinical changes in thyrotoxicosis. Pure iodine has been used by Marine and Lenhart (1911) and Starr, Walcott, Segall, and Means (1924), potassium iodide by Neisser (1920), Loewy and Zondek (1921), and Cowell and Mellanby (1924), sodium iodide by Jagić and Spengler (1924), tincture of iodine (2.5 per cent iodine, 1.5 per cent potassium iodide in alcohol) by Trousseau (1868) and Waller (1914), hydriodic acid by Fitzgerald (1926), Sajodin (calcium iodobenzenate)

by Fulton and Ault (1930), and Lugol's solution (5 per cent iodine, 10 per cent potassium iodide in water) by Plummer (1923), Starr, Walcott, Segall, and Means (1924), and many others. In addition to the oral administration, iodine has also been given with benefit by inhalation as ethyl iodide (Lerman and Means, 1931). Reference is also made in general text-books to the successful administration of iodine intravenously, rectally, or simply by skin application. It is clear, therefore, that iodine is rapidly absorbed through the skin or through any mucous membrane, and that iodine or any of its salts are equally effective. There are several publications, among others by Fitzgerald (1926) and Fulton and Ault (1930), showing clearly that the form in which iodine is administered is of little consequence. The most popular form in which iodine is given is Lugol's solution, and this is doubtless due to the influence of Plummer, who chose this mixture "because it was an aqueous solution of iodine and provided a large amount of iodine loosely combined with potassium." It is interesting to note that Lugol described the preparation of this solution in 1830 as a cure for tuberculous infections. His memoir in an abstracted form was later translated into English by Markwick (1846).

**Dosage of Iodine**—There is still some controversy about the ideal or proper dosage of iodine in thyrotoxicosis. The consensus of opinion would appear to be that for the prolonged treatment of thyrotoxicosis by iodine alone, the dosage should be small and in the region of 6-12 mg of iodine daily (1-2 drops of Lugol's solution), but that as a pre-operative measure the dosage should be much larger. As this paper is concerned with the preparation of patients for surgery, this will now be considered. It is not clear why such large doses of iodine are necessary or advisable as a pre-operative measure. Although Thompson, Bailey, Thompson, and Thorp (1930) maintained that the minimum amount of iodine that will produce the maximum reduction in the basal metabolism is not greater than 6 mg of iodine daily (1 drop of Lugol's solution), they have stated for no apparent reason that five times this amount should be given daily before operation. Plummer and Boothby (1924) go further and state that a minimum of ten drops of Lugol's solution is desirable, as they observed certain patients who did not react to five drops but did to ten drops daily. It was also their experience that an increased dosage of ten drops three times per day produced better and quicker responses. Both Neisser (1920) and Loewy and Zondek (1921) appeared to have introduced the scheme of increasing the daily dosage of iodine from fifteen drops of potassium iodide solution to an optimum of sixty drops. This system has been advocated by Joll (1932), who started with five drops of Lugol's solution three times per day and increased the amount by three drops per day until the dosage was thirty to forty-five drops per day a few days before the operation.

It was with a view to clarifying the various actions of iodine on the basal metabolism in thyrotoxicosis that the following experiments were designed. In view of conflicting reports, a critical inquiry was made into iodine dosage and the types of iodine therapy used as pre-operative measures.

## EXPERIMENTAL

In *Table I* are given a list of solutions and salts of iodine in common use, with details regarding their composition and the amount of total iodine. As all forms of iodine are equally effective it can be

*Table I*—SOLUTIONS AND SALTS OF IODINE, WITH COMPOSITION AND AMOUNT OF TOTAL IODINE

IODINE COMPOUND	FREE IODINE	SALT OF IODINE	VEHICLE	TOTAL IODINE (FREE IODINE PLUS IODINE IN COMBINATION)
<b>Liquid —</b>				
1 Liq iodi mitis (B.P., 1932) or Tinct iodine	2.5 per cent	Potassium iodide, 1.5 per cent	Alcohol	1 min contains 2.16 mg
2 Liq iodi simplex (B.P., 1932) or Tinct iodi (French Codex of 1908)	9.0 per cent	Nil	Alcohol	5.33 mg
3 Lugol's solution (B.P., 1936)	5.0 per cent	Potassium iodide, 10 per cent	Water	7.49 mg
4 Hydriodic acid	—	Hydrogen iodide, 10 per cent	Water	5.89 mg
<b>Solid</b>				
Potassium iodide				1 gr contains 49.6 mg
Sodium iodide				54.9 mg
Ethyl iodide				52.9 mg
Sajodin (calcium iodobenzenate)				15.6 mg

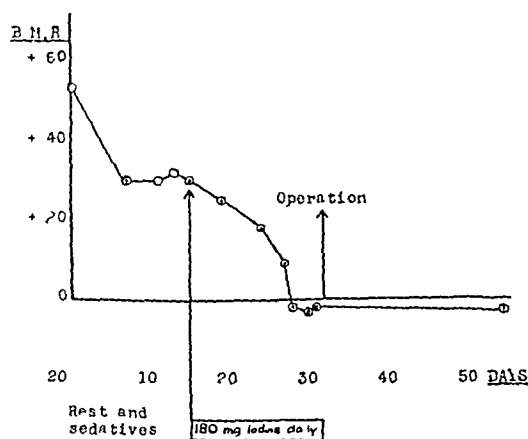
calculated from *Table I* that 30 minims of Lugol's solution are roughly equivalent to  $4\frac{1}{2}$  gr of potassium iodide and 4 gr of sodium iodide each containing approximately 220 mg of iodine. In the results which follow iodine was given in amounts of 180 to 200 mg daily in the form of pure iodine, Lugol's solution, or potassium iodide, but, as previously explained, these different forms of iodine have no significance.

The basal metabolism was measured by the closed-circuit method, the accuracy of which has been reported (Robertson, 1937). The apparatus used was the Benedict-Roth with recording kymograph. All machines were alcohol-checked (Barrett and Robertson, 1937) and found accurate, but in addition each was checked once a week by a model whose basal metabolism is in the region of 56 calories per hour. All subjects studied were in-patients, but the technique of measuring their basal metabolism was essentially the same as that described for out-patients (Robertson, 1944). The subjects were brought to a room in the Courtauld Institute with a temperature of 20–23° C from the wards in chairs on at least two successive mornings under basal conditions. If, on the second day, the duplicates agreed within 5 per cent (and were lower than the first-day readings) the lower reading was taken as the basal metabolism. On the other hand, if the duplicate readings were not within 5 per cent, or the second readings were higher than those on the

first day, then readings were taken on subsequent days until a constant reading was obtained. Such difficulties were experienced in 5 per cent of cases. After the initial reading had been determined, a further reading was taken in ten to fourteen days and thereafter daily or on alternate days until a constant reading was obtained after simply rest and sedatives. Then 180–200 mg of iodine was given daily, and the basal metabolism again measured daily or on alternate days after the seventh day of iodine therapy, until or unless a constant reading was obtained. Charts 1–5 (*Figs 262–266*) show observations on the basal metabolism in five selected cases of thyrotoxicosis, illustrating how the action of iodine can vary from case to case and in the same case from time to time. In Chart 6 (*Fig 267*) the different reactions of the basal metabolism in thyrotoxicosis to iodine is given diagrammatically.

In the series of cases investigated it was found that simple rest in bed and sedatives brought about a fall of 15 to 40 per cent in the initial basal metabolism.

*Chart 1 (Fig 262)*—In thirteen days the maximum reduction in the basal metabolism took place, and operation was carried out on the seventeenth day of iodine therapy. The post-operative basal



*Fig 262*—Chart 1 M.C., aged 35

metabolism was not significantly different from the lowest basal metabolism after iodine. This is the most satisfactory type of iodine response, in which is produced a maximum fall in basal metabolism to the patient's normal level.

*Chart 2 (Fig 263)*—Iodine brought about a fall in the basal metabolism to the region of +30, and no further improvement took place. Iodine was unable to control the thyrotoxicosis further. Successful subtotal thyroidectomy was carried out with a post-operative basal metabolism of -9 and well below the lowest reading on iodine.

*Chart 3 (Fig 264)*—The first course of iodine produced a curve similar to that in Chart 2. Instead of operating with a basal metabolism in the region of +30, it was decided to stop the iodine for a period of two months and to give the patient sedatives. At the end of two months iodine produced a marked fall in the basal metabolism to -3, at which level a successful subtotal thyroidectomy was carried out.



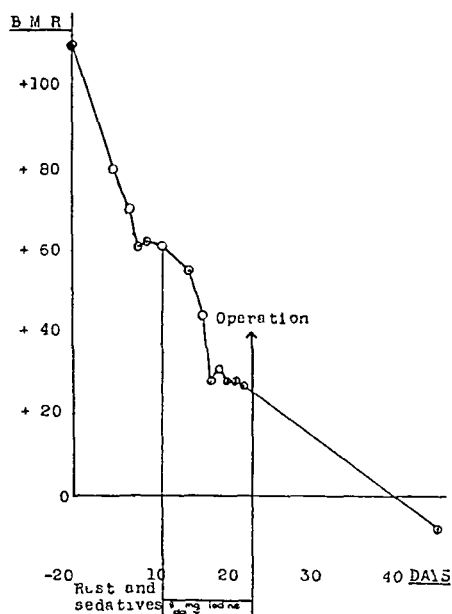


FIG 263—Chart 2 E C, aged 42

Chart 4 (Fig 265) —This shows a most interesting response of the basal metabolism to iodine

Days of Iodine Therapy	Basal Metabolism
None	+ 50
9	- 5
10	- 13
11	0
14	+ 8
15	+ 15
18	+ 22
21	+ 40

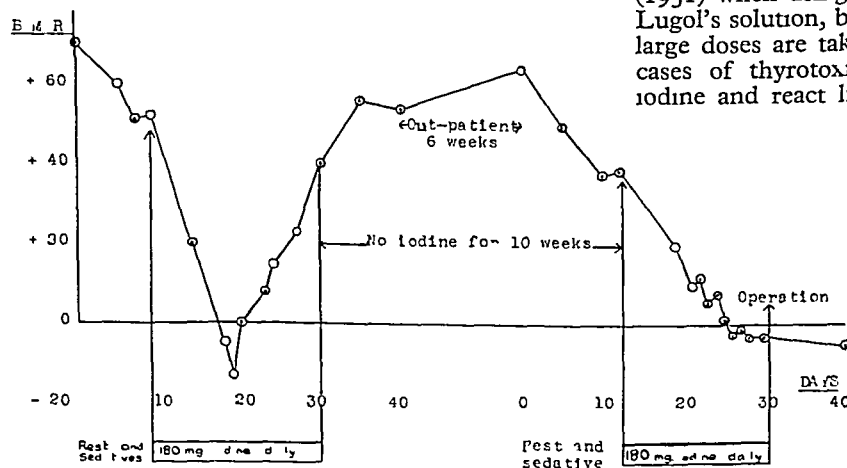


FIG 265—Chart 4 L H, aged 23

Iodine was now replaced by sedatives for six weeks and the basal metabolism rose to + 60. The next course of iodine brought about a steady fall in the basal metabolism to a plateau in the region of - 3, at which stage a subtotal thyroidectomy resulted in a post-operative reading of - 5. This case presented many interesting features. It showed the value of carrying out not isolated, but serial, basal metabolism determinations. Thus, if after

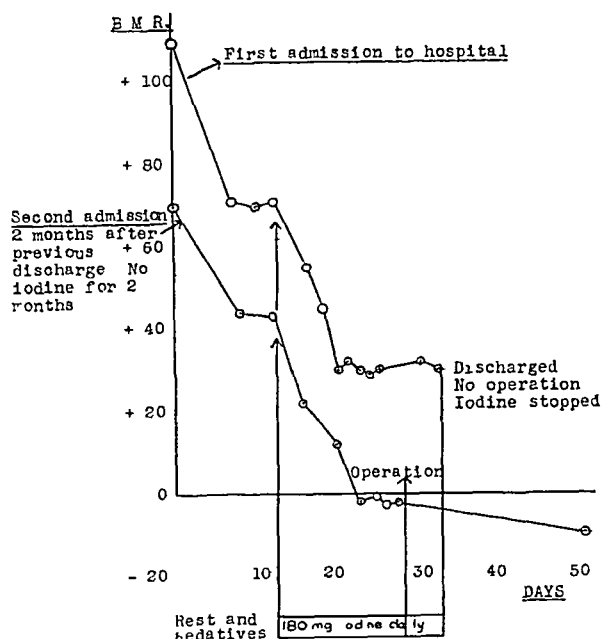


FIG 264—Chart 3 W D, aged 28

the initial reading of + 50, further single readings were taken on the eleventh or the fourteenth day of iodine therapy the results of 0 or + 8 would have created the erroneous impression that the basal metabolism was falling, when, in fact, it was 'on the rise'. This is an example where a case becomes 'refractory' to iodine, and the drug loses its power to control the thyrotoxicosis. The condition has been well described by Thompson and Thompson (1931) when using small doses equal to 1 minim of Lugol's solution, but it also appears to develop when large doses are taken. It is important to recognize cases of thyrotoxicosis that become refractory to iodine and react like the first curve in Chart 4, as operation, if carried out when the metabolism is rising, is invariably accompanied by a thyroid crisis.

Chart 5 (Fig 266) —Iodine caused an increase in the severity of the disease as shown by a rising metabolism from + 30 to + 45 in twenty-five days. Iodine was stopped for a month. The second course was followed by a steady fall in the basal metabolism to a plateau in the region of + 10, at which level a subtotal thyroidectomy was carried out resulting in a post-operative reading of - 5. This case is unusual in that an active case of thyrotoxicosis was made clinically worse with iodine. It has already been reported by Kocher (1910) and Plummer and Boothby (1924), that adenomatous goitres without hyperthyroidism could be rendered toxic by the administration of iodine.

Chart 6 (Fig 267) —This chart shows diagrammatically the different responses of the basal metabolism to iodine. From the point of view of operative



risk, the first two reactions are the most satisfactory. With the other two reactions with a rising metabolism the operative risk may be great.

### DISCUSSION

It is difficult to understand why Lugol's solution should be the most popular form in which iodine is taken. It has a most objectionable burning taste,

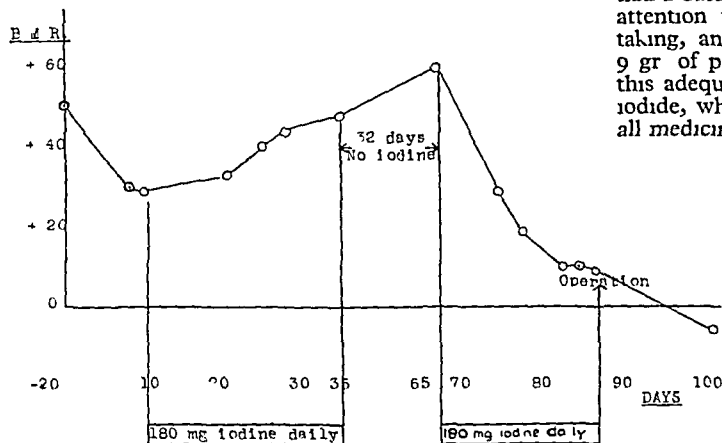


FIG 266—Chart 5 J. M., aged 50

and the custom of giving it in drops is far from accurate, unless the solution is diluted to teaspoonful or other reproducible types of dosage. It is probable that the influence of Plummer, who chose this solution because it contained a large amount of

dose of iodine) is equivalent to  $4\frac{1}{2}$  gr of potassium iodide and 4 gr of sodium iodide each containing approximately 220 mg of iodine. It is important to realize that all soluble compounds of iodine are equally effective, as the following experience will demonstrate —

A case of obvious thyrotoxicosis with exophthalmos had a basal metabolism of +4. In reporting this result, attention was drawn to the fact that the patient was taking, and had taken for the previous fourteen days, 9 gr of potassium iodide in a cough mixture. Despite this adequate control of the thyrotoxicosis by potassium iodide, when subtotal thyroidectomy was decided upon, all medicines were stopped and the patient given 15 min of Lugol's solution daily for ten days before operation. This case, therefore, for fourteen days was having 448.4 mg of iodine as potassium iodide, with the thyrotoxicosis controlled, yet, because of a rule-of-thumb routine, Lugol's solution was given for ten days before operation, providing only 102.4 mg of iodine, or less than a quarter the patient was receiving on potassium iodide.

There appear to be many advantages in employing as a pre-operative measure iodine in the form of potassium or sodium iodide. These medicines are not unpleasant and small doses of 2–2½ gr per day (equivalent to 15 min of Lugol's solution) are adequate in the preparation of cases of thyrotoxicosis for operation. On the other hand Lugol's solution, at present the most popular of iodine mixtures, lacks the advantage of simple iodides. It has been established that the minimum dose of iodine

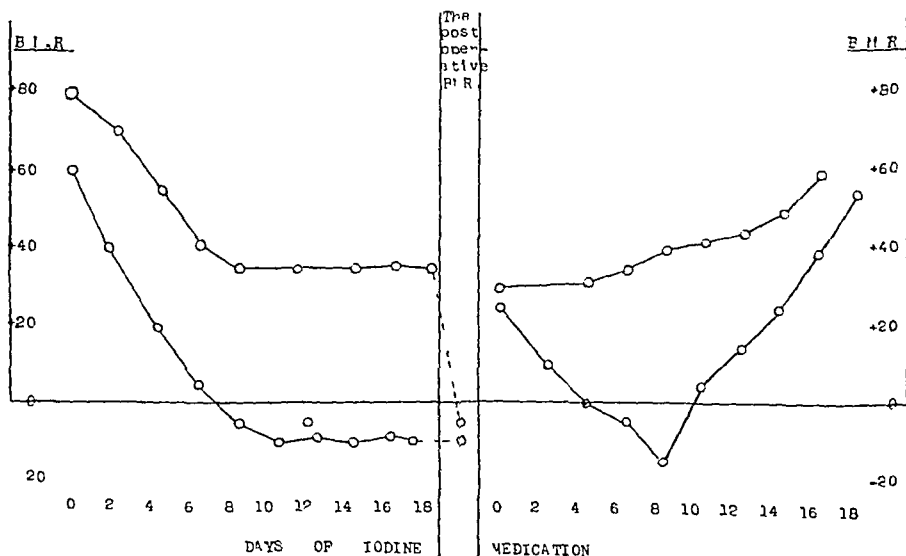


FIG 267—Charts showing the different reactions to iodine in thyrotoxicosis

aqueous iodine, persists. Plummer may not have been aware that all salts of iodine were equally effective, and that the ability of iodine compounds to reduce the basal metabolism in thyrotoxicosis does not depend on the presence of free iodine, but soluble iodide. It has been shown that 30 min of Lugol's solution (a common pre-operative daily

that will produce the greatest clinical improvement and maximum reduction in the basal metabolism in thyrotoxicosis is in the region of 6 mg, or about 1 min of Lugol's solution. As a pre-operative measure, iodine in excess of minimum requirements has been advocated, and doses from 5–30 min per day are employed in various clinics. There is a

practice among some surgeons to give increasing doses of iodine, starting with 3 min three times daily and working up to 10-12 min thrice daily on the day before operation. This complicated system of iodine dosage is not governed by an experimental or scientific reasoning, and has nothing to commend it. It is, in fact, an undesirable procedure, for small doses of iodine can inhibit the maximum response of large doses. It would seem reasonable to commence and continue with large standard doses of 2-4 gr of sodium or potassium iodide, or 15-30 min of Lugol's solution, daily until the subject is ready for operation.

It has been stated by several investigators that the maximum benefit from iodine in thyrotoxicosis usually occurred after eight to ten days of medication. It has, however, been emphasized that this maximum improvement might be delayed two or even three weeks, and that it was inadvisable to operate until it was clear that no further improvement could be obtained from the iodine, even if this involved a delay of several weeks. Unfortunately, instead of adopting this sound principle first elaborated by Plummer and his colleagues of the Mayo Clinic, it is customary in certain clinics to replace this technique by a rule-of-thumb procedure whereby the operation takes place after ten days of iodine medication, irrespective of whether the maximum improvement has taken place or not. This has resulted, not uncommonly, in severe post-operative reactions. In assessing the maximum clinical improvement of a case under iodine, the basal metabolism is probably the best single guide. It is appreciated, of course, that a surgeon with much experience in thyroid surgery can by his personal judgement form an accurate opinion of the clinical state of a case of thyrotoxicosis. But all surgeons are not so fortunate, and for those without that experience, or those in the process of acquiring it, the basal metabolism can give a very accurate index of the iodine-control of the thyrotoxicosis, and the ability of the patient to withstand operation. In the present study it was found that, after due allowance had been made for rest and hospitalization, the basal metabolism fell to its lowest level with iodine in a period varying from six to twenty-five days. If patients are given iodine immediately on admission to hospital it seems probable that iodine will take longer than the above range to exert its maximum control. The danger in operating is not so much in delaying it, as in carrying it out too early during iodine therapy. It is important to realize that all cases of thyrotoxicosis do not react alike to iodine, nor any one case at different times. Iodine appeared to cause four well-defined reactions in thyrotoxicosis: (1) A fall in the metabolism to a low plateau which equalled or was not significantly different from the subject's normal basal metabolism obtained after a successful operation; (2) A fall in the basal metabolism to a plateau which is significantly higher than the basal metabolism after a successful operation; (3) A sharp fall in the basal metabolism, followed immediately by as sharp a rise; (4) A rise in the basal metabolism. The ideal pre-operative condition of the patient is one in which the basal metabolism is reduced by iodine to as low a level as possible and at the same time constant. The second condition

is easier to achieve than the first, with the result that many operations are performed on patients with a constant basal metabolism, yet one that is raised well above normal. In these types of cases it is sometimes advisable to postpone operation until a more favourable response to iodine is obtained. Operation is contra-indicated when the basal metabolism is rising, a condition in which the patient is refractory to iodine. When it is considered that operation is not without risk for any of the above reasons, iodine should be stopped and replaced by sedatives such as quinine hydrobromide and luminal and a high-calorie diet, including glucose up to 6 oz daily for four to six weeks. After iodine has been omitted for from four to six weeks, the thyrotoxicosis reverts to its primary untreated condition, and iodine again is able to bring about an artificial remission in the disease. It has erroneously been stated that the first iodine remission is the best. This is incorrect. Provided a period of four to six weeks of freedom from iodine medication is allowed to elapse, then iodine will continue to exert its control on the thyrotoxicosis.

In interpreting observations on the basal metabolism in thyrotoxicosis, it is important not to rely on isolated readings, particularly in the case whose basal metabolism suddenly falls, then rises, on iodine. Several readings at daily or two-day intervals will indicate how a case is reacting to iodine, whereas a single reading on the twelfth day would mislead. Thus, by the twelfth day of iodine medication the basal metabolism might, after a sharp fall, be 'on the rise', yet the figure, being lower than the initial reading, would erroneously imply that the basal metabolism was falling.

In this section a study has been made of the basal metabolism in thyrotoxicosis, and the relationship between the various reactions of the basal metabolism to iodine and the operability of the case. It is, of course, appreciated that there are other factors of importance to guide the surgeon in performing a successful subtotal thyroidectomy—such as the skill of the surgeon, his decision on the extent of surgery the patient's condition permits, the type of operation, the pre-operative treatment excluding iodine, the anaesthesia, and the immediate post-operative treatment. With these very important aspects of surgery of the thyroid gland, this paper is not concerned. It is believed, however, that one, if not the most important single assessment of a patient's ability to withstand a thyroid operation for thyrotoxicosis is the response to, and the level of the basal metabolism after, iodine medication. So-called thyroid surgeons, before and after the value of iodine was appreciated, have used their own judgement in deciding when to operate and their mortality-rates were low. Less experienced surgeons were not so fortunate. It is for the latter type of surgeon that the basal metabolism, as a means of assessing the ability of patients to withstand operation, can be of invaluable help.

## SUMMARY AND CONCLUSIONS

1. Iodine and all its soluble compounds are equally effective in controlling thyrotoxicosis. The total amount of iodine in 30 min of Lugol's solution (5 per cent iodine, 10 per cent potassium iodide in

water) is equivalent to that in  $4\frac{1}{2}$  gr of potassium iodide and 4 gr of sodium iodide each containing approximately 220 mg

2 The disadvantages of Lugol's solution far outweigh its advantages as the ideal iodine compound in the treatment of thyrotoxicosis. The iodides of sodium or potassium are more satisfactory.

3 The system, which at present prevails in some clinics, of giving gradually increasing doses of iodine, has no justification. This unnecessary complication in dosage only confuses medical treatment, and it has no advantages over a constant daily dose of about 200 mg of iodine.

4 The basal metabolism is probably the best single guide in assessing when a case of thyrotoxicosis is ready for operation. Surgeons experienced in thyroid surgery can rely, and have relied, on their clinical judgement in place of measurement of the basal metabolism, but for less experienced surgeons measurement of the basal metabolism provides a ready means of assessing the clinical state of the patient at any time during iodine medication.

5 The rule-of-thumb procedure of operating on cases of thyrotoxicosis after ten days of iodine medication is not without risk. The reason is that the maximum improvement obtained from iodine does not always occur on the tenth day—it may be earlier and it may be later. By the tenth day of iodine medication iodine may have lost its ability to control the thyrotoxicosis, and with the basal metabolism rising operation is not without risk.

6 Iodine causes four different types of reaction on the basal metabolism in thyrotoxicosis, and in two of the types operation on the thyroid is contra-indicated. These types of reactions are best detected by carrying out several basal metabolism determinations throughout iodine therapy. An isolated reading on the tenth or twelfth day of iodine medication, common in certain clinics, may give misleading information. Thus, by the tenth or twelfth day, the iodine may have lost its ability to control the thyrotoxicosis and the basal metabolism started to rise. At this point a reading would be lower than the initial basal metabolism, implying that the basal metabolism was falling.

7 The belief that iodine will produce its best response when given for the first time is incorrect. Provided an interval of four to six weeks has elapsed, when no iodine or its compounds have been taken, it will bring about its typical remission of the thyrotoxicosis again.

## II THE POST-OPERATIVE REACTION AFTER SUBTOTAL THYROIDECTOMY FOR THE RELIEF OF THYROTOXICOSIS

In the previous section it was stated that it seemed desirable to depress the basal metabolism to as low a figure as possible with iodine before operating on the thyroid. In the description of the cases that follow an attempt is made to prove that this procedure is justified. The proof is based on measurements of the basal metabolism immediately after subtotal thyroidectomy on cases where iodine brought about a varied response pre-operatively. In some cases iodine succeeded in causing the basal metabolism to fall to within normal limits, but in

others iodine only brought about a slight fall and operation was carried out when the basal metabolism was at a high level.

Observations on the basal metabolism in cases of thyrotoxicosis immediately after operation have been reported by Sturgis (1923), Boothby (1921), Eberts (1921), and Segall and Means (1924). In this paper the findings of the above authors have been extended to include not only thyrotoxicosis, but also non-toxic goitre, simple glands of neck, and abdominal operations in an attempt to determine whether the post-operative rise in the basal metabolism is specific for a thyroid that is producing a toxic secretion.

### METHODS

All metabolism determinations were carried out under strictly basal conditions. The pre-operative determinations were measured in a room in the Courtauld Institute where the patients were brought from the wards in chairs. In cases of thyrotoxicosis the first basal metabolism plotted on the chart was the reading taken after rest and sedatives had taken effect and was 15 to 40 per cent lower than the initial observation. After a constant reading was obtained 180 to 200 mg of iodine were given daily in the form of potassium or sodium iodide or Lugol's solution. The second basal metabolism determination charted was the lowest constant reading reached after iodine, and this occurred, as stated in the previous paper, in from six to twenty-five days. The post-operative readings were taken in the wards at the bedside behind screens. For the first two mornings after operation the patients complained of difficulty in swallowing and painful necks, but the discomfort was not such as to prevent them having their basal metabolism measured. When fever was present, and this commonly occurred after operation, the necessary correction in the basal metabolism by subtracting 7.2 per cent for each degree F was made as suggested by Dubois (1936).

In taking the temperature the thermometer was left in the mouth for six minutes and the readings were taken before those of the basal metabolism.

Pulse-rate readings of a minute's duration were taken at intervals during the metabolism determination, but only the lowest rate was recorded.

Blood-pressure was taken at the conclusion of the metabolism determination, and while the patient was still at rest.

In Chart 7 (Fig 268) are the pre- and post-operative records of the basal metabolism in three selected cases of thyrotoxicosis showing different responses to iodine. In 'JD' the basal metabolism could not be depressed below +50, in 'AC' it fell to the lower figure of +24, while in 'MD' it fell to within normal limits. On the day after operation there was a rise in the basal metabolism in all three cases, the rise being greatest (47 per cent) where the pre-operative metabolism on iodine was the highest (i.e., JD at +50), and only 15 per cent where iodine had caused the metabolism to fall to normal (i.e., MD at -2). The fall in metabolism from the peak on the first day after operation was rapid, reaching normal limits in three to nine days, the return to normal being most rapid in the case where iodine had reduced the basal metabolism to

normal before operation The basal pulse-rates recorded on Chart 8 (Fig 269) followed the curves of the basal metabolism closely

thyroidectomy for non-toxic goitre, and after operations for secondary glands in the neck and chronic appendicitis It will be seen that all curves are

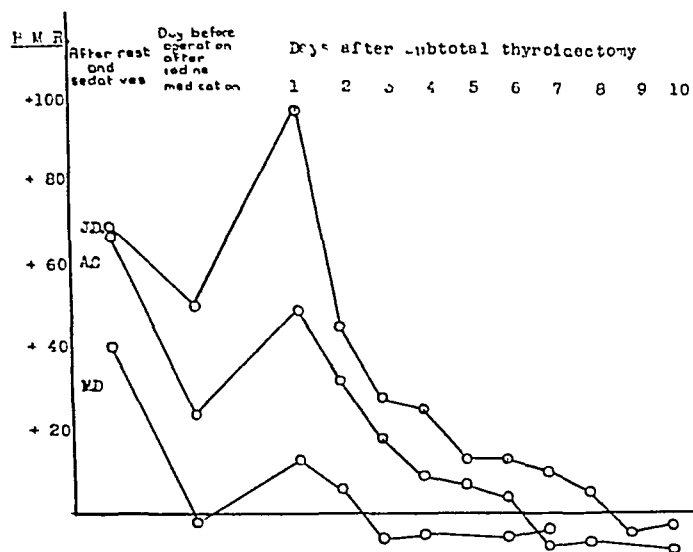


FIG 268—Chart 7. Pre- and post-operative basal metabolic rate records in three cases of thyrotoxicosis, showing different responses to iodine

It is commonly believed that the post-operative reaction after subtotal thyroidectomy for the relief of thyrotoxicosis is indicative of a pouring out of a toxic secretion from the thyroid gland into the general circulation This apparently is supported by the findings in Chart 7, which showed that the post-operative reaction is most marked in the case with the highest pre-operative basal metabolism after

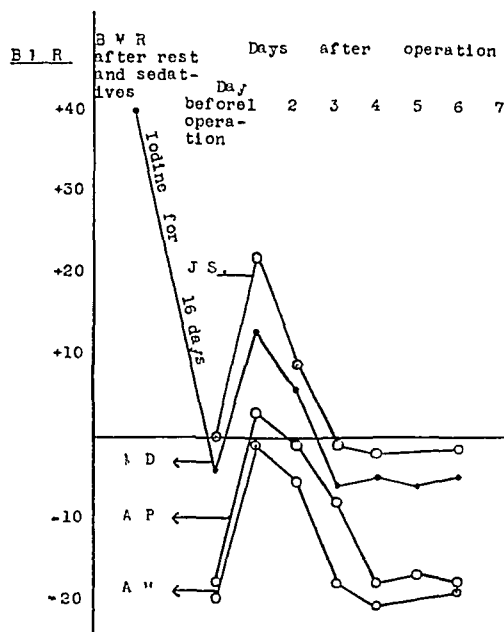


FIG 270—Chart 9. Comparison of post-operative curve of basal metabolism in a case of thyrotoxicosis reduced to normal with iodine (M.D.), with those of J.S., Subtotal thyroidectomy for relief of non-toxic goitre, A.P., For chronic appendicitis, A.M., For removal of secondary glands of neck

comparable both as regards the percentage rise in metabolism of the peak on the day after operation, and the length of time the metabolism takes to return to normal The pulse-rates are not charted, but they again followed the course of the metabolic rates closely The post-operative rise in the basal metabolism is therefore not specific for thyrotoxicosis, but it occurs to the same degree after operations for the relief of non-toxic goitre, glands in neck, and chronic appendicitis

Attention has been drawn by Lerman (1930) and Means (1937) to a temperature reaction of several days' duration which invariably accompanies the convalescence following subtotal thyroidectomy for thyrotoxicosis In Chart 9 the daily temperatures after operations for the relief of thyrotoxicosis, non-toxic goitre, and chronic appendicitis are plotted The findings of Lerman and Means are confirmed that fever, not associated with any evidence of infection, is present for several days after operations for the relief of thyrotoxicosis This post-operative temperature reaction does not appear to be specific for operations on toxic goitres, as it also is present after operations on non-toxic goitre, for chronic appendicitis, and for removal of secondary glands in neck (not charted in Chart 10 (Fig 271) in order to avoid confusing the other three curves)

In Chart 11 (Fig 272) variations in the systolic blood-pressure after the various types of operations

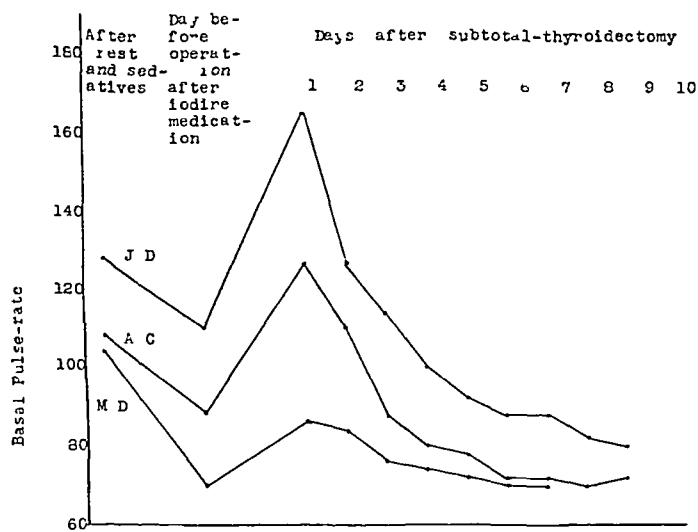


FIG 269—Chart 8. Basal pulse-rates in same cases as in Chart 7, showing the close approximation to the basal metabolism curves

iodine medication, i.e., the most severe grade of thyrotoxicosis In Chart 9 (Fig 270) the post-operative curve of the basal metabolism in a case of thyrotoxicosis, reduced to normal with iodine, is compared with the curves following subtotal

are plotted. It will be seen that the blood-pressure rises after operations but returns to normal in two to three days, and that the elevations in blood-pressure are of the same degree irrespective of the nature of the operation.

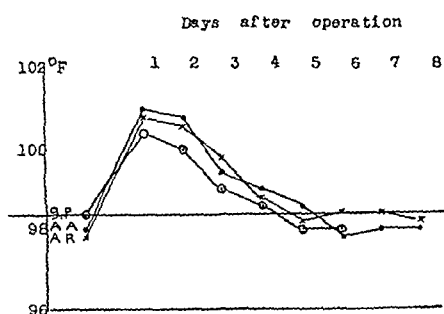


FIG 271—Chart 10 Temperature recordings after operations for the relief of thyrotoxicosis (A A), non-toxic goitre (A R), and chronic appendicitis (G P)

In the operations described above for the relief of the thyrotoxicosis, non-toxic goitre, appendicitis, glands of neck, and the like, various types of anaesthesia were employed such as the different forms of local, general, and local plus general.

Despite the use of different anaesthetics, the post-operative metabolisms appeared to be dependent only on the level of the pre-operative basal metabolism and unaffected by the type of anaesthesia employed. A study of the effects of a general anaesthetic on the basal metabolism was made, however, and the findings are shown in Chart 12 (Fig 273). The patients were given an anaesthetic to allow of a

to find a slight fever of 99° F on the day following the administration of the anaesthetic.

## DISCUSSION

After subtotal thyroidectomy for the relief of thyrotoxicosis, there is a post-operative reaction which is well-known to surgeons and nursing staff. This includes an increased pulse-rate, a raised metabolism, and fever, with the peak on the day after operation falling to a normal level in six to eight days. No satisfactory reason has been given to explain the fever, which is not an indication of infection. It is tempting to ascribe the whole post-operative reaction to a pouring out of thyroid secretion from the gland into the general circulation.

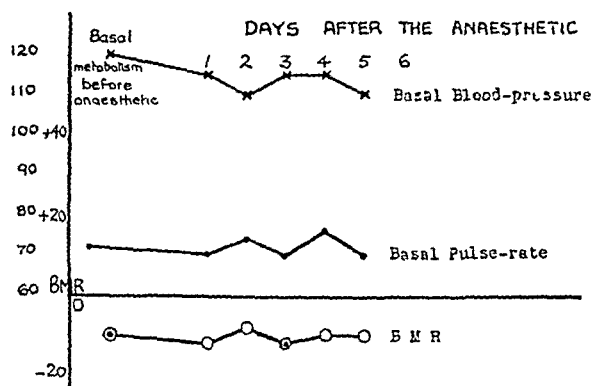


FIG 273—Chart 12 Showing effect of general anaesthetic on the basal metabolism

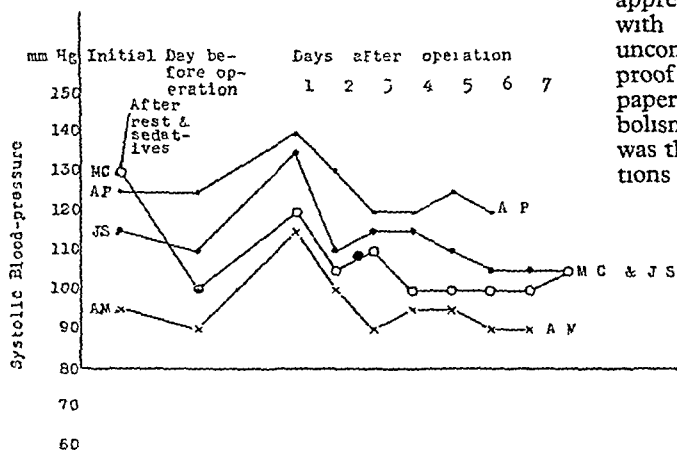


FIG 272—Chart 11 Variations in systolic blood pressure after various types of operations. J S, Subtotal thyroidectomy for non-toxic goitre, M C, Subtotal thyroidectomy for thyrotoxicosis, A P, For chronic appendicitis, A M, For removal of secondary glands of neck.

simple gynaecological examination or an insufflation of the Fallopian tubes, but no surgical procedure involving trauma or incisions was carried out. In no case was the basal metabolism, in the days following the anaesthetic, above that of the pre-operative level. Observations on the pulse-rate and systolic blood-pressure also showed no significant change. It was, however, noted that it was not uncommon

There would appear to be support for this when it is appreciated that thyrotoxicosis is a disease associated with tachycardia, a raised metabolism, and not uncommonly a temperature above normal. Further proof for this concept seemed to be given in this paper, when it was found that the higher the metabolism on the day before operation, the more marked was the post-operative reaction. When the observations were extended, however, to include non-toxic goitre, tuberculous and malignant glands of the neck, and chronic appendicitis, it was found that the post-operative reaction was of the same degree as that obtained in thyrotoxicosis. It would appear, therefore, that the syndrome of tachycardia, increased metabolism, and fever following subtotal thyroidectomy for the relief of thyrotoxicosis is simply the result of a surgical operation and is not due to any specific thyroid factor.

In order to determine whether the anaesthetic was responsible for the post-operative reaction, a series of cases which were anaesthetized but not submitted to any surgical procedure involving trauma to skin vessels or organs were studied. It was found that the anaesthetic *per se* did not cause an increased basal metabolism or tachycardia.

## SUMMARY AND CONCLUSIONS

I After subtotal thyroidectomy for the relief of thyrotoxicosis there is a post-operative reaction which includes a raised basal metabolism, fever, tachycardia, and increased blood-pressure with

the peak on the day after the operation, and a return to normal in six to eight days

2 This post-operative reaction is not specific for operations on a toxic goitre, but is present to the same degree after operations on non-toxic goitre, glands of neck, and for chronic appendicitis

3 The syndrome is not present after the administration of an anaesthetic unaccompanied by any surgical trauma. It appears, therefore, that the typical reaction, which invariably follows an operation, is due solely to the effects of surgery and not to the anaesthetic

### III THE EFFECTS OF IODINE MEDICATION AFTER SUBTOTAL THYROIDECTOMY FOR THYROTOXICOSIS

Plummer (1923) was the first to suggest giving iodine post-operatively in order to combat the severe reaction which invariably followed subtotal thyroidectomy for the relief of thyrotoxicosis. This was based on the assumption that the operative mortality was due to a lack of iodine, resulting in the secretion from the thyroid gland of an incompletely iodized product with very toxic properties. The administration of iodine after subtotal thyroidectomy according to Plummer caused a sharp fall in the post-operative deaths. In a later publication with Boothby (Plummer and Boothby, 1924) a careful study was made of the effects of iodine in thyrotoxicosis before operation. This paper, with others of a similar

Thus Means (1937) gave iodine for ten days after operation, when the patient is discharged. Joll (1932) increased the iodine in twenty-four hours following operations, then reduced it to 10 min of Lugol's solution daily for ten to twelve days. Among others, Pemberton (1926), Else (1929), and Jackson (1929) continued iodine for varying periods after operation. On the other hand, Davison and Aries (1939) believed that iodine administration after operation was not important. They compared a group of cases having iodine post-operatively with another group having no iodine, and they found no difference in the reactions as judged clinically and by the temperature, pulse-rate, and respiration.

The incidence of thyrotoxicosis following subtotal thyroidectomy for the relief of that condition has been well reviewed by Thompson, Morris, and Thompson (1930), and it ranges in different clinics from 0.25 to 25 per cent. Controversy still exists whether the thyrotoxicosis which occurs after subtotal thyroidectomy is due to a persistence or a recurrence of the disease. It has been suggested that if the basal metabolism remains within normal limits one to two months after iodine has been stopped, then any thyrotoxicosis subsequent to this is due to a recurrence of the disease, and any thyrotoxicosis previous to this is due to a persistence.

In the description of the cases which follows an attempt is made to determine the merits of giving iodine as a post-operative measure, and at the same time to find a means of assessing as early as possible a successful subtotal thyroidectomy.

### EXPERIMENTAL

In order to observe the effects of iodine on the post-operative reaction following subtotal thyroidectomy for thyrotoxicosis, two groups of cases were studied. In one group iodine was commenced after the usual period of rest and it was continued for fourteen days after operation. In the second group iodine was stopped the day before operation. In Chart 13 (Fig 274) typical curves of the basal metabolism in a case from each group are shown. It will be seen that the post-operative rises in metabolism on the day following operation are of the same degree, and in each case the basal metabolism falls to normal limits within a week. It is apparent, then, that, if patients are adequately prepared for operation with iodine, it is not necessary to continue its administration after the thyroid has been removed.

As iodine does not appear to play an essential part in the after-treatment of subtotal thyroidectomy, it was decided to investigate whether its administration had any disadvantages. It is well known that iodine causes the basal metabolism of thyrotoxicosis to fall, and that its action wears off after it has been stopped. The duration of the so-called iodine control of the basal metabolism and of the symptoms of thyrotoxicosis, both during its actual administration and after it has been stopped, is not well defined. An opportunity arose for making observations on the latter in a surgical case and the basal metabolism findings are plotted on Chart 14 (Fig 275).

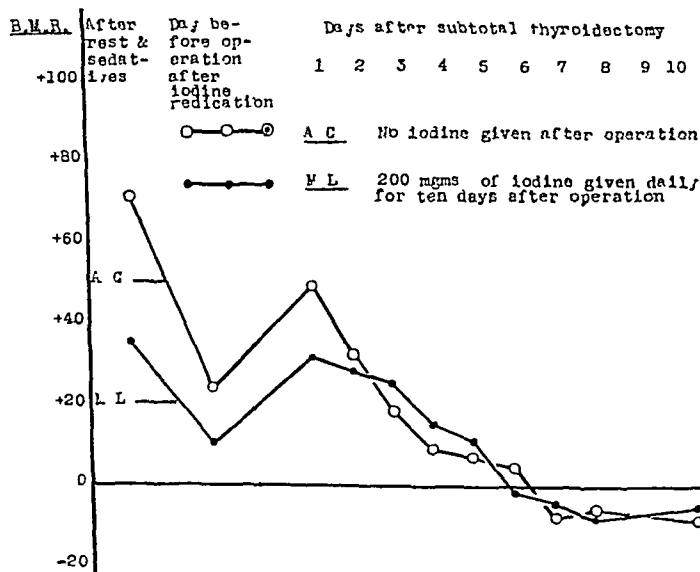


FIG 274—Chart 13 Showing the effect of iodine on the post-operative reaction following subtotal thyroidectomy for thyrotoxicosis

nature, has been discussed in the first section. In clinics where the teachings of Plummer and Boothby are observed, thyroid operations are carried out when iodine has brought about the maximum improvement, and this may vary from so short a time as six days to as long a time as twenty-five days. It is the custom in most clinics to continue the iodine after thyroid operations for several weeks or months.

E J, aged 18, was a case of thyrotoxicosis with the right lobe of the thyroid much more enlarged than the left, so that clinically she was labelled an adenoma of the thyroid. Iodine brought about a steady fall in the basal metabolism to the region of 3 in seventeen days, at which level the surgeon decided, instead of performing the customary subtotal thyroidectomy, to remove the right lobe of the gland only. Iodine was stopped on the day before operation, as a routine, and after an uninterrupted convalescence the basal metabolism was measured on the twelfth day after operation before discharge from hospital. The basal metabolism was +20, i.e., higher than the level to which iodine had

was then given for several days before as well as after operation. The beneficial effects of pre-operative iodine in thyrotoxicosis have been described in detail by Plummer and his colleagues at the Mayo Clinic. They showed that iodine brought about a marked clinical improvement and a fall in the basal metabolism, and that if operation was delayed until iodine had produced its maximum effect, the post-operative reaction was diminished accordingly.

It is the custom in most clinics to continue iodine for several weeks or months after thyroid operations. This appears to be due to two reasons. First, it is

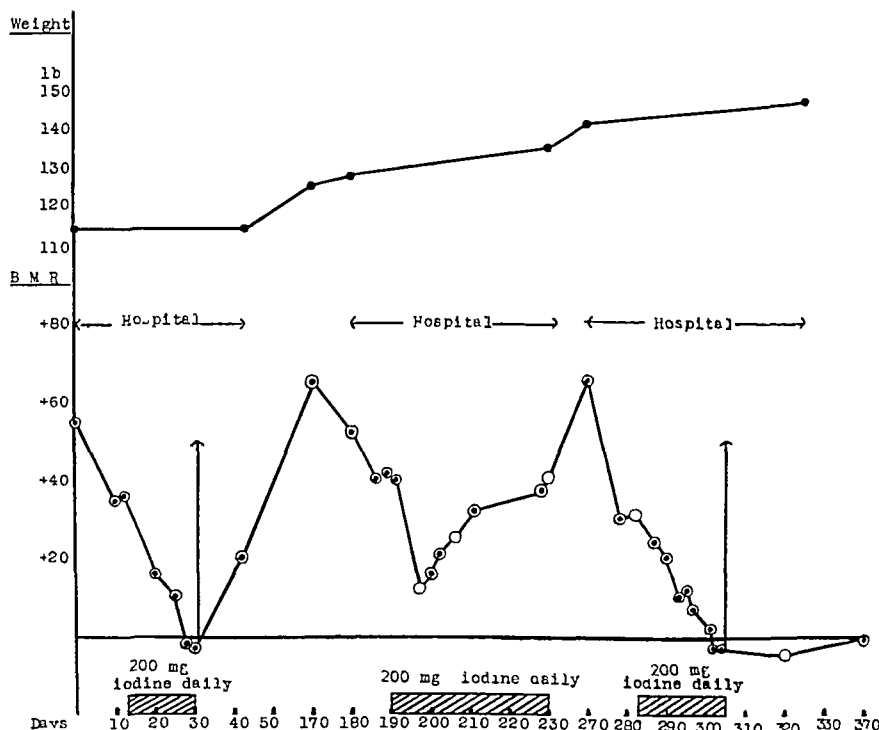


FIG 275—Chart 14 Basal metabolism findings in a study of iodine control in a surgical case of thyrotoxicosis

reduced it before operation, and also raised above the limits of the normal controls. Despite the metabolism findings, a cure was claimed to have been established clinically. In four months' time the patient returned to hospital for a routine re-examination. By this time her basal metabolism was +65, and clinically it was now obvious that thyrotoxicosis was present despite a gain of weight of almost 11 lb. She was taken into hospital for a further operation, and her progress is shown in Chart 14.

On iodine the basal metabolism fell from +40 to +12 in seven days, following which the patient became refractory to iodine and the basal metabolism began to rise despite iodine medication. Iodine was therefore stopped, but recommenced in six weeks' time. On this occasion a steady fall in the basal metabolism took place to the region of -3, at which level about seven-eighths of the gland remnant was removed. A satisfactory post-operative basal metabolism of -5 resulted.

### DISCUSSION

Iodine was first given for several days *after* subtotal thyroidectomy for thyrotoxicosis in order to control the severe, often fatal, post-operative reaction. This procedure was later altered, and iodine

believed that when the thyroid gland of a case of thyrotoxicosis is cut, and absorption of the gland toxin takes place into the general circulation, iodine is supposed to neutralize this toxin and control the resultant post-operative reaction. Secondly, it has been claimed that the post-operative administration of iodine prevents regrowth of thyroid tissue and a recurrence or a persistence of the thyrotoxicosis. With regard to the theory of a toxic absorption from the cut surfaces of the gland, evidence has been brought forward in a previous paper which suggests that this hypothesis is unlikely. Further, the administration of iodine after subtotal thyroidectomy did not control the increased basal metabolism in the days following the operation. The post-operative rise and decline in the basal metabolism was the same whether iodine was administered or not. Observations on the pulse-rate and body temperature agreed with the basal metabolism findings. It would appear, therefore, that iodine has no therapeutic value when given after subtotal thyroidectomy provided it has been given in adequate amounts before operation. The claim

that post-operative iodine can prevent regeneration of thyroid tissue and recurrence of the thyrotoxicosis is based on the observations of Marine and Lenhart (1909), who demonstrated that iodine inhibited compensatory hypertrophy of a normal thyroid remnant following removal of part of the gland. This view is not shared by the majority of workers, and it seems probable that iodine plays no part in the prevention of a persistence or a recurrence of the thyrotoxicosis after subtotal thyroidectomy. It is interesting to note that Thompson, Thompson, and Morris (1930) found little difference in the rate of recurrent thyrotoxicosis in the days before iodine was used (17.1 per cent) compared with the rate since the introduction of iodine (19.5 per cent). It appears, then, that recurrent or persistent thyrotoxicosis is independent of iodine administration, but rather it is related to some other cause such as the nature of the operation, the cause of the disease, or the like. As a corollary to the above, evidence has been brought forward in this paper to show that if iodine administration after subtotal thyroidectomy cannot do any good, then it probably may do harm. The administration of iodine after operation has the disadvantage of temporarily masking an active thyrotoxicosis, which will only become apparent after the iodine is stopped or until the patient becomes refractory to it. It is believed that if iodine is stopped on the day before subtotal thyroidectomy, then it will be possible to state by the twelfth day after operation (i.e., before the patient leaves hospital) whether a successful operation for thyrotoxicosis has been carried out or not. If the basal metabolism on the twelfth day after operation is significantly higher than the lowest pre-operative reading after iodine or above the limits of the normal controls, then the thyrotoxicosis is persisting and an inadequate amount of gland has been removed, and this despite absence of tachycardia, gain in weight, and other evidences of clinical improvement. In other words, the basal metabolism is a most sensitive index of the presence or absence of thyrotoxicosis.

# SUMMARY AND CONCLUSIONS

1 If a case of thyrotoxicosis is given iodine in adequate amounts and subtotal thyroidectomy is carried out when the maximum clinical improvement with iodine has taken place, there is no need from a therapeutic point of view to continue iodine after the operation. Iodine given after subtotal thyroidectomy does not exert any control on the post-operative reaction. The post-operative rise and decline in basal metabolism, the pulse-rate, and body temperature in cases treated with iodine post-operatively were similar in those cases treated without iodine post-operatively.

2 If iodine is not continued after subtotal thyroidectomy it is possible to state by the twelfth day after operation whether the thyrotoxicosis has been relieved. If the basal metabolism on the twelfth day after operation is higher than the lowest pre-operative level or above normal limits, then the thyrotoxicosis has not been relieved. The basal metabolism is a more sensitive index of an unsuccessful operation for the relief of thyrotoxicosis than the pulse-rate, the weight, or the clinical symptoms.

The author has much pleasure in thanking the honorary staff of the Middlesex Hospital for permission to investigate their cases. He also has pleasure in acknowledging the gift of a metabolism machine from the Government Grants for Scientific Investigations, through the Royal Society.

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## In Memoriam

### ARTHUR TUDOR EDWARDS

(1890—1946)

THE death of Tudor Edwards has robbed the world of a master-surgeon and Britain of the most brilliant operator in the domain of thoracic surgery. Though only 56 years of age, he had long acquired a veritably international reputation, and his pupils, assistants,



TUDOR EDWARDS  
(1890—1946)

and those who had come under his influence and spell are to be numbered in every Dominion and in many countries outside the British Empire.

The years of early training were spent in Middlesex Hospital, a fruitful nursery of surgical operators. Tudor Edwards served in two wars, doubtless his experience of forward surgery in the 1914-18 armageddon first directed his thoughts towards the thorax as his own future surgical province, the recent world war found him giving of his knowledge and experience in the role of consultant for injuries and diseases of the chest to the Ministry of Health, to the War Office, and to the Royal Air Force. Tudor had rightly approached the specialty which was to make him world-famous along the avenue of general surgery, and his contacts with such men as Bland-Sutton, Moynihan, and Cuthbert Wallace cannot have failed to exert some influence on his surgical outlook.

His chest surgery was learned from no other pioneer, but carved out of the hard rock of personal experience. He was perhaps fortunate in the exact moment of his surgical activity, for the great advances in anaesthesia facilitated his work, and Tudor Edwards was also blessed in the co-operation of wise physician-colleagues, particularly at Brompton Hospital, who were possessed of vision and who reposed their complete confidence in him. To-day outstanding surgical achievements are not consummated by the lone worker, but by the man who can organize and inspire colleagues, assistants, and nursing staff to form one harmonious loyal unit. The leadership of Tudor Edwards attracted around him such a coterie of acolytes. The number of hospitals he served was legion. Westminster, the London, Queen Mary's, Roehampton, Midhurst, Millbank, and many others, doubtless his heart lay in Brompton, but he served each institution with fidelity and brought lustre and distinction wherever he was attached.

Surgical honours came to him in abundance from colleagues at home and from universities and learned associations abroad, he was an Honorary M.D. of Grenoble and of Oslo Universities, an Honorary Fellow of the American Society of Thoracic Surgeons, he had occupied the presidential chair of various British associations concerned with the chest, he was a valued member of the Council of the Royal College of Surgeons of England. The written word is often a meretricious avenue to international reputation, Tudor Edwards's fame has rested and will rest on his deeds rather than words, although 33 papers under his name are chronicled in the *Cumulative Index* and there was also that last notable paper in the first number of the new journal *Thorax*, in which he summarized his experiences in over 1000 cases of bronchial carcinoma, including 70 cases in which he had performed pneumonectomy or lobectomy for this disease.

Despite the menace of a malady which finally carried him off, he continued to soar aloft to the surgical empyrean, disdaining the black cloud of death which threatened his life so long. The amount of work which he accomplished was prodigious and more and more exacting in its character. Like the Emperors Vespasian and Hadrian, who when reproved for activities prejudicial to failing health replied, "An Emperor must die standing", Tudor obstinately refused to spare himself. Perhaps no man has borne so heavy a medical burden, for there were few physicians or surgeons who did not turn to him for help for themselves or their kith and kin when stricken with thoracic maladies.

The man who achieved all this was no leaden superman, but a vital figure with all the charms and graces. The pioneer is seldom the exploiter, but Tudor Edwards was happily spared to see the water of early conviction become the red wine of

established faith He lived to enjoy the satisfaction, not only of gazing retrospectively on his own brilliant pioneer achievements, but of looking forwards into the promising vista which his work had opened up Well might he have exclaimed in the words of Valiant-for-Truth, "Yet now I do not repent me of all the trouble I have been at to arrive where

I am My sword I give to him that shall succeed me in my Pilgrimage, and my Courage and Skill to him that can get it "

*Pulchrumque mori succurrit in armis \**

\* *Aeneid*, II, 317

## SHORT NOTES OF RARE OR OBSCURE CASES

### A CASE OF ACUTE PANCREATITIS WITH SUBCUTANEOUS FAT NECROSIS

By HUGH BLAUVELT

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FAT necrosis due to acute pancreatitis is commonly seen within the abdomen where it affects the mesentery, the omentum, the pancreas, and the peritoneum Outside the abdominal cavity fat necrosis is rare except in the extraperitoneal fat The occurrence of necrosis in more distant regions and structures

Nausea and vomiting occurred the day before she entered hospital The bowels were constipated and micturition was difficult The previous history revealed no detail of importance

ON ADMISSION—The patient looked seriously ill T 99.6°, P 120, R 24 The abdomen was not distended, but there was generalized tenderness and rigidity and



FIG 276—Showing the pigmented areas in the right thigh

—the mediastinum, the pleura, the pericardium, the marrow of long bones, and the peri-articular fat—has been observed, but except in connexion with the experimentally produced acute pancreatitis of animals no record can be discovered of necrosis developing in the subcutaneous fat

In the case of acute pancreatitis herein described areas of fat necrosis were present in the subcutaneous fat covering most of the body

#### CASE REPORT

M C, a married woman 41 years old, was admitted to the North Middlesex County Hospital on Oct 27, 1939, complaining of epigastric pain of two days' duration

these were more marked over the gall-bladder The diagnosis lay between acute cholecystitis and acute pancreatitis

The following day many red areas resembling the eruptions of erythema nodosum appeared upon the skin of the legs and arms

FIRST OPERATION—On Oct 29 laparotomy was decided upon The incision in the abdominal wall revealed necrosis of the extraperitoneal fat and the peritoneal cavity was not opened A portion of one of the superficial lesions on the right leg was excised and the cut surface showed the typical appearance of fat necrosis

DESCRIPTION OF THE SKIN LESIONS—The superficial areas of fat necrosis were confined to the arms, legs, and buttocks, with the exception of two lesions which were

situated on the back immediately to the right of the 11th dorsal spine. All the lesions appeared during the first week of the illness, but two were discovered for the first time five weeks after her admission to hospital. Of these two nodules, one was about 2 in. below and to the left of the umbilicus, and the other was situated in the subcutaneous tissue of the right flank.

The distribution of the lesions in the affected parts was not uniform, the most extensively involved areas being the upper and outer aspects of the thigh and the tissues close to and below the knee. The lesions on the right leg were more numerous than those on the left.

In size the lesions varied from a mark no larger than a pin-prick to a round or oval patch 2 in. or more in diameter, the majority measured about  $\frac{1}{2}$  in. across. All the lesions exhibited the same round or oval shape and in no case was any marked irregularity in the outline observed (Fig 276).

The surface of several of the spots was slightly raised above the level of the surrounding skin. Unlike the remaining and more numerous ones, these plaques were softer in the centre than towards the periphery and they thus resembled small abscesses, suppuration, however, did not occur in any one of them.

Microscopical examination of the portion of tissue removed at operation displayed the characteristic features of fat necrosis and showed no evidence of cellular activity or of vascular reaction.

#### TESTS AND INVESTIGATIONS—

*Urinalysis* (Dec 21) Catheter specimen of urine—red blood cells, pus, and *B. coli*. These abnormalities no doubt were due to infection from previous catheterization.

*Urinary Diastase* Oct 30, 2400 units for 24 hours, representing an index of 10, Dec 21, 8700, or an index of 6.

*Blood-sugar* (Nov 3) 90 mg per 100 c.c.

*W.B.C.* Oct 30, 12,500, Dec 21, 7200.

*Loewi's mydriatic reaction*, positive.

*Radiographs* of the abdomen showed signs of gall-stones. Radiographs of the limbs on several occasions showed nothing abnormal until July, 1940, when vague shadows were present suggestive of calcification in the necrotic lesions.

**CLINICAL PROGRESS**—Retention of urine occurred during the first six days following operation and was treated by repeated catheterization. Eight days after operation 10 oz. of fluid containing yellow flakes was vomited. Unfortunately this was thrown away, but the yellow substance was described by a nurse as being "like soft butter". Up to this date in hospital the patient had received no fat in her diet.

Recovery proceeded slowly. She left hospital on Dec 21, about eight weeks after admission.

When examined as an out-patient seven months after the beginning of the illness all external signs of fat necrosis had disappeared with the exception of a few rose-coloured areas on the thighs. No abnormal thickening was detected in any of these patches.

**SECOND OPERATION**—On Aug 7, 1940, she was re-admitted to hospital and cholecystectomy was performed on the following day. The operation presented no difficulty and two small stones and a chronically inflamed gall-bladder were removed. On Aug 10 she became comatose and death followed 24 hours later. The blood-urea before death was 200 mg per 100 c.c.

**POST-MORTEM EXAMINATION**—The abdomen showed no sign of infection, hæmorrhage, or bile leakage. The

liver, bile-ducts, and pancreas were normal and no evidence was found of recent or of old fat necrosis. The kidneys were small, contracted, and granular, and no doubt death was due to chronic nephritis. In the limbs no calcified areas were found.

## COMMENT

Fat necrosis in acute pancreatitis is due to the action of lipase upon the neutral fat of the tissues. The immediate result of this reaction is the production of glycerin and fatty acid. Following this the fatty acid unites with calcium to form an insoluble soap. This soap is the essential constituent of the opaque plaques which characterize fat necrosis.

**The Transportation of Lipase to the Site of the Lesion**—Lipase may be carried from the diseased pancreas to the various regions where fat necrosis has been observed in a number of ways. The lesions so frequently found in the peritoneum and mesentery and in the pancreas itself are usually regarded as the result of the direct spread of the liberated ferment. When the extraperitoneal fat, the pleura, the pericardium, and the mediastinum are affected the lipase is said to travel by way of the lymphatics. Necrotic lesions in the bone-marrow and peri-articular tissues have been attributed to pancreatic emboli travelling through the blood-stream. In the case of subcutaneous fat necrosis described in this paper such a method of dissemination would best account for the occurrence of the lesions.

A study of the blood-vessels draining the pancreas suggests that when the gland is acutely inflamed favourable conditions exist for the transference of minute particles of pancreatic tissue to the portal blood-stream. The portal vein is formed near the head of the pancreas by the union of the splenic and superior mesenteric veins. The pancreas itself is drained by many small vessels which open directly into the splenic, the superior and inferior mesenteric, and the veins along the greater curvature of the stomach. When the head of the pancreas is inflamed and swollen the portal vein is likely to be pressed upon close to its origin. As a result of this venous obstruction the pancreas becomes congested and microscopical portions of tissue may be absorbed and eventually reach the systemic circulation.

**Involvement of Stomach and Bladder**—In the author's case the possibility of submucous lesions in the stomach and their separation and appearance in the vomited material cannot be overlooked. The fact that no blood was observed in the stomach contents is evidence, but not proof, against such an occurrence.

Dysuria is not a rare symptom in acute pancreatitis and it may be explained by the presence of areas of fat necrosis underneath the peritoneum of the bladder. A deposit of this nature in contact with the muscle tissue of the bladder might interfere with the neuromuscular mechanism of micturition.

## A CASE OF CONGENITAL MULTIPLE ARTERIOVENOUS FISTULÆ OF THE HAND

By J A WHITE

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CONGENITAL arteriovenous fistula of the extremities would appear from the literature to be a rare condition. Pemberton and Saint (1928) reported 9 cases at the Mayo Clinic between 1916 and 1928. Lewis (1930) collected 24 cases from the literature and described 6 of his own. Other writers have reported one or two cases. Horton (1932), however, produced a series of 23 from the Mayo Clinic between 1929

surface. The hand was used by the patient for all ordinary purposes, and its function was fair. Elevating the arm caused the dilated veins to disappear. With the stethoscope a continuous-cycle bruit with systolic accentuation could be heard over most of the hand, but was maximum on the palmar surface at the base of the first finger. The bruit was high-pitched and musical, and could be heard conducted as high as the right supraclavicular fossa. No murmur could be detected above

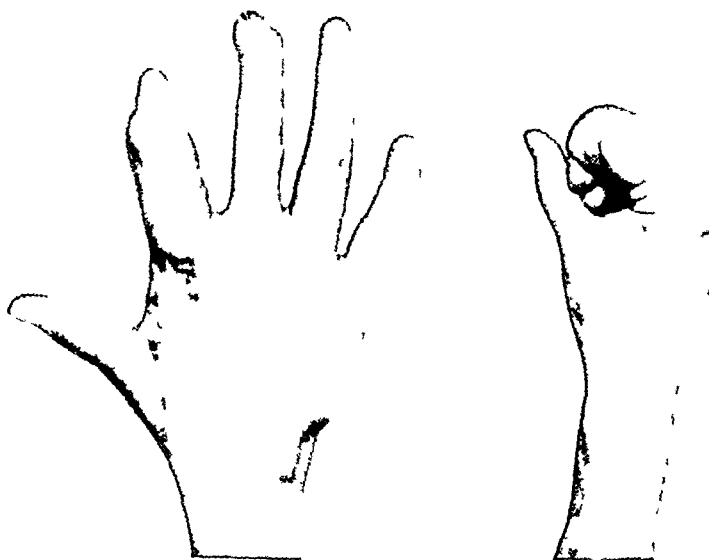


FIG 277—Photographs of affected right hand, showing deformities, dilated veins, and normal thumb

and 1931. Some of these were only diagnosed by the venous oxygen content, and had no murmur or thrill, so it is possible that the condition is not so rare, but sometimes escapes recognition. Bone changes and local gigantism are reported in many of the cases, but malacia of the semilunar has not been mentioned.

### CASE REPORT

A girl aged 12 was first seen on Feb 7, 1943. The mother stated that a purplish discoloration of the right hand had been present from birth. Disproportionate increase in the size of the hand, associated with some deformity, had been noticed in the last two or three years. The patient's only complaint was of mild pain in the deformed fingers and in the wrist.

ON EXAMINATION—The patient was an intelligent healthy girl. The right hand showed a large irregular port-wine stain on both palmar and dorsal surfaces. The whole hand, with the exception of the thumb, which was quite normal, was swollen and covered with dilated tortuous veins. Dilated veins were also present in the forearm. The four fingers showed gigantism and deformities (Fig 277). A thrill was palpable, maximum in the palm. In addition to the radial and ulnar arteries, four deep pulsating vessels could be palpated, one on the palmar surface and three on the dorsal

the wrist when a tourniquet had first been applied at this level, thus proving the arteriovenous communications responsible for murmurs to be at or below the wrist. This was not absolute proof, however, that other communications did not exist higher up, as cases have been described without murmurs (Horton, 1932).

The right hand was definitely warmer, and usually moister, than the left. The heart showed no clinical signs of enlargement or abnormality. The right humerus, radius, and ulna were approximately half an inch longer than the left.

The blood-pressure findings were interesting and were taken with the experimental model of the M E M sphygmoscope (Mendelssohn et al, 1945) as it was found to be very difficult to determine the pressure in the

SITE	SYSTOLIC PRESSURE	DIASTOLIC PRESSURE
Affected upper arm (R)	(mm Hg) 125	(mm Hg) 40
Normal upper arm (L)	95	60
Normal upper arm (L) (with compression of R brachial artery)	95	50
Right thigh	120	50

affected arm with the ordinary blood-pressure machine. This instrument has since been found very helpful in taking distal limb pressures in traumatic aneurysms.

At rest the pulse-rate was 90, and it dropped to 83 with compression of the right brachial artery (Branham's or Nicoladoni's sign).

*X-ray Findings* (Figs 278, 279)—Report by Dr Feuchtwanger —

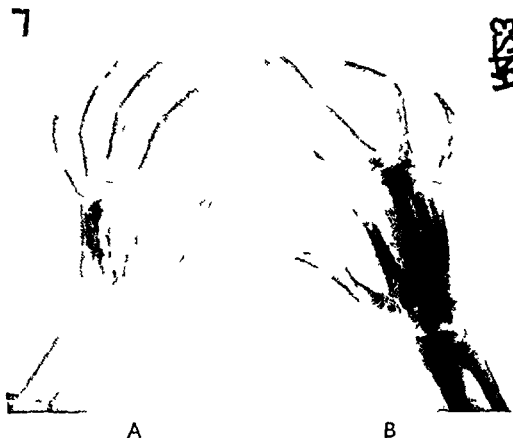


FIG 278—A, Radiograph of affected hand, B, Radiograph of normal hand for comparison

"*Both Hands* Hyperostosis, i.e., excessive size and development, of right 2nd, 3rd, 4th, and 5th metacarpals. Thumb of normal size and length. Deformity of right radial and ulnar epiphysal regions, with slight lateral displacement of radial epiphysis. The right semilunar is smaller than the left and shows irregularity of bone structure, i.e., localized bone atrophy combined with beginning sclerosis, appearances of Kienbock's disease. Extensive destruction of proximal interphalangeal joint of index finger and distal interphalangeal joint of middle finger. Shafts of 2nd, 3rd, and 4th right proximal phalanges show irregular trabeculation and increased bone striation as seen usually in hæmangioma. The left hand shows no radiological abnormality. *Arteriogram* Injection into right radial artery about 1½ in above wrist-joint. Right radial artery filled. No filling of thumb area. Extensive arterial filling of palmar arch with marked accumulation of opaque medium between heads of 2nd and 3rd metacarpals. Soft tissues of index finger show vascular filling of moderate density. Venous dilatation in lateral carpometacarpal region."

The arteriogram suggests multiple fistulæ but gives no definite information as to number or site. It also suggests small aneurysmal sacs in the region of the 2nd and 3rd metacarpophalangeal joints, and this was the region which was first attacked surgically. Another arteriogram into the mid-brachial artery, but not giving such a good picture, is not included. It gives no further information, but it also fails to show filling of arteries to the thumb.

*TREATMENT AND PROGRESS*—Injections of sclerosing fluid (5 per cent sodium morrhuate) into regional veins and subcutaneous injections over the site of maximum murmur had no effect. Incidentally, the maximum murmur has recently, in some traumatic arteriovenous fistulæ, been found at some distance from the actual lesion. This has been on the proximal side of the fistula, where a deep vein, in its course back to the heart, has been approaching the surface.

Four attempts at surgical extirpation over a period of eight months produced no clinical improvement, and the patient was discharged.

Follow-up discovered that a severe hæmorrhage had later necessitated amputation through the forearm at another hospital.

## DISCUSSION

*Treatment*—Surgery and sclerosing injections failed to produce any improvement. The condition can only be cured by closing all the fistulæ, and in most cases they are multiple and minute. Surgery is also made very difficult by the angiomatic tissue. Horton (1932) states that "apparently" only three cases have been cured by surgical measures. He advocates injection of the regional veins with a sclerosing fluid in an attempt to obliterate the abnormal communications, and reports that in one case there was an "apparent" cure. In most cases it is probably best to do nothing until the heart is affected, and then amputation will be necessary. It is possible that the unsuccessful surgery in this reported case precipitated the necessity for amputation before the heart was showing any signs of being affected.



FIG 279—Arteriogram of vessels of right hand. Injection was into radial artery just above wrist.

*Bone Changes*—This case shows hypertrophy, rarefaction, epiphysal changes, joint destruction, and a patchy sclerosis of the semilunar. All the changes must be attributed to the vascular disorder, but it is interesting to speculate on the mechanism. The hypertrophy and epiphysal changes must surely be due to the increased blood-supply to the limb, and occurred in the radius, ulna, and humerus, which were probably above the fistulæ, as well as in the hand. The rarefaction and joint destruction are certainly due to invasion by the angiomatic

tissue. It is difficult to explain the complete normality of the thumb, except by postulating a separate blood-supply from high in the upper arm, which seems improbable, although arteriograms with injection into the brachial artery in the middle of the upper arm and the radial just above the wrist failed to show any of the arteries to the thumb.

The generally accepted view of Kienbock's disease is that it is fundamentally due to a disturbance of blood-supply. Many authors have suggested injury as the cause of this disturbance, but it is interesting to note that Cave (1939) could only find one case in the literature following palmar dislocation, where the main posterior blood-supply must be damaged. Sclerosis often occurs, but revascularization and not collapse follows. Jackson Burrows (1941) stresses the differences between aseptic necrosis and osteochondritis, and produces some experimental evidence that cutting off the arterial blood-supply produces aseptic necrosis and not osteochondritis. He suggests that either venous obstruction or hæmatoma formation within the nucleus may be the causal factor of osteochondritis. In this case one can imagine an arteriovenous communication between the main nutrient artery and vein just proximal to the semilunar. This would cut down the arterial supply to the bone, but would also increase the pressure in the vein with consequent venous obstruction. Other suggestions have been reflex vasomotor constriction (Leriche), embolic occlusion (Axhausen), endarteritis obliterans and thrombosis (Wirts), and Mouatt et al have described the conditions following phlegmon of the hand and scarlet fever. The above authors were quoted by Horton (1943).

**Blood-pressure Findings**—The interesting fact here is the great increase in systolic pressure in the affected arm. The possibility that this might be due to a temporary rise of general pressure

following occlusion of the arteriovenous communications while taking the reading, was ruled out by taking the pressure in the normal arm while occluding the blood-supply to the affected side.

The systolic pressure was unaltered and the diastolic slightly lowered, as shown in the table of blood-pressures. Holman (1937), in his experimental fistulæ, reports considerable rise in general blood-pressure, both systolic and diastolic, when the fistula is occluded. That this did not happen in this case can be explained partly by the minuteness of the communications (the small drop in pulse-rate is additional evidence of this), and partly by the adaptability of a youthful circulation.

Holman also describes the enlargement of proximal vessels which we know occurs above a fistula. The blood-pressure in a normal leg is higher than that in a normal arm, and larger vessels are mainly the cause of this. The increased systolic pressure in the affected arm in this case may likewise be attributed to the larger vessels.

The lower diastolic pressure in the affected arm can be explained by the diminished peripheral resistance due to leakage through the fistulæ.

Horton (1932) records the pressures of both limbs in four of his cases. In three the pressure was much higher on the affected side, and in one a little lower.

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## A CASE OF MELORHEOSTOSIS

By A. DAVID LE VAY, LONDON

THE purpose of this paper is not to supply an exhaustive survey of melorheostosis, but to add a fourth case to the three cases hitherto published in the British literature.

Boggon (1938) described a case in a man of 30, in whom the right side of the pelvis, the right tibia and fibula, and the bones of the right foot were affected, in association with gummatous ulceration.

Fairbank (1939) regarded a case of Wakeley's, a boy of 8 in whom both legs were affected, as a true instance of melorheostosis and a link with the generalized form of osteosclerosis (Albers-Schönberg). This is incidentally the only case ever described with well-marked bilateral features.

Franklin and Matheson (1942) recorded a very extensive involvement of the skull, spine, pelvis, and the bones of the arm and leg, all on the right side, in a woman of 41.

The case described by Hall (1943), and that of Hilton (1934) quoted by Hall, cannot be regarded

as true instances of the disease, for the X-ray appearances are quite atypical.

The present findings were an accidental radiographic discovery in a boy of 9 with mild knock-knee. There is involvement of the left ischium, the outer half of the lower femoral epiphysis, both fibular epiphyses, the talus, cuneiforms, and third and fourth metatarsals and phalanges, all on the left side (Figs 280-283). There were no symptoms, and no signs apart from a palpable thickening on the dorsum of the foot. Serum-calcium, plasma-phosphorus, and phosphatase were normal.

The purely epiphyseal location in the fibula and femur is interesting and somewhat unusual. It will be noted that the shaft of the fibula, though not sclerosed, is almost twice the thickness of the right, with considerable blurring, and is presumably exhibiting presclerotic changes. There are similar changes in the upper half of the left femur.



FIG 280—Sclerosis in the left ischium, thickening of the shaft of the left femur



FIG 281—Sclerosis in the outer half of the left lower femoral epiphysis and in the upper epiphysis of the fibula

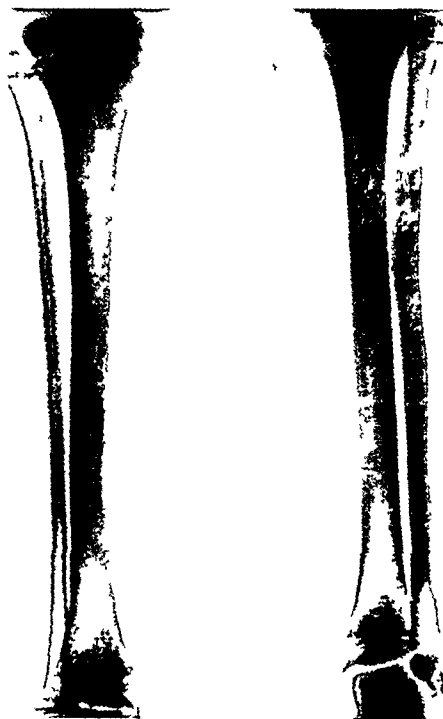


FIG 282—Deposits in both left fibular epiphyses, with blurring and thickening of the fibular shaft



FIG 283—Splashes of sclerosis in the cuneiforms, metatarsals, and phalanges of the left foot

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# CONstriction OF THE EXTENSOR POLLICIS BREVIS TENDON AN UNUSUAL LESION SIMULATING DE QUERVAIN'S DISEASE

By JOHN A SHEPHERD

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STENOSING tenovaginitis (de Quervain's disease) is a well-recognized and fully documented condition, first described in 1895 (Scheidner, 1928). In adults it usually affects the extensor pollicis brevis or the abductor pollicis longus, and in children has been described (Zadek, 1942) involving the flexor pollicis longus. In the common extensor type the patient complains of pain in the region of the radial

may be conservative or surgical. Immobilization may reduce the swelling of the sheath in an early stage of the condition. More satisfactory to surgeon and patient alike is the operative exposure of the tendon under local anæsthesia, the sheath is laid open and the free action of the thumb can at once be demonstrated.

Such was the condition in mind in examining and submitting to operation the patient described below but an unusual and unexpected lesion was disclosed.

## CASE REPORT

A naval officer aged 42 was admitted to hospital on July 18, 1945, complaining of pain in the right thumb. He recorded seven months' disability due to pain at the

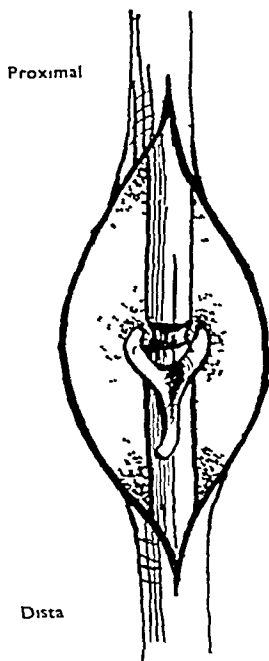


FIG 284—Diagram of appearance on opening tendon-sheath. The long limb of the occluding structure detached from the roof of the sheath the two short limbs attached to floor of sheath and the whole embracing the tendon tightly but unattached to tendon. Note the groove in the tendon from which the structure slipped off with a jerk.

styloid and of difficulty in straightening the thumb, such that manipulation may be required. Passive movements meet with resistance and the thumb may extend with a definite 'snap'. Classically, adduction at the wrist is free if the thumb be free, but is limited and painful if the thumb is included with the fingers in testing this wrist movement. There may be slight swelling over the affected tendon. The pathology tends to occur where the abductor pollicis longus and the extensor pollicis brevis pass beyond the osteofibrous canal overlying the lower end of the radius, and on exposure there is seen a fibrous thickening of the tendon sheath. This tissue is hard and cuts like gristle, and it restricts the free play of an otherwise normal tendon. The histology suggests the reaction of trauma rather than infection, and certainly many cases occur in women using their hands with, for example, the monotonous regularity of housework. Treatment



FIG 285—Photograph of structure as it appeared after excision. View of under-surface ( $\times 2$ ).

base of the thumb. There was no history of trauma, but he ascribed the condition to excessive writing during the previous year. Full abduction was difficult because he "felt something catching" and at times he noticed a "click" as he extended the thumb.

ON EXAMINATION—He was in perfect health. He pointed to the line of the tendon of extensor pollicis longus as the site of a radiating pain from wrist-joint level to the interphalangeal joint of the thumb. On palpation there was tenderness just distal to the radial styloid in the line of the extensor pollicis brevis. All movements were quite free, but there was slight pain on full extension of the thumb referred to the tender area. He considered that the symptoms were variable and that at the time of examination the condition was somewhat less troublesome. No definite click was heard on movement. When examined on a previous occasion symptoms had been more marked and the adduction test noted above was positive. Although there was no palpable swelling, a pre-operative diagnosis of de Quervain's disease was made. At his own request a general anæsthetic was arranged.

OPERATION (July 19)—With a pneumatic tourniquet on the upper arm an incision was made along the line of the extensor pollicis brevis from the radial styloid 1 in. distally. A tendon-sheath of normal thickness and consistency was exposed and slit open in the length of the incision, to reveal the tendon tethered by a peculiar band of tissue (Fig 284). The paired limbs of this structure arose from the floor of the sheath on each side of the tendon and embraced the latter tightly over the volar



aspect—tightly enough to cause a local constriction of the tendon. The single limb merged with the roof of the sheath and reference to *Fig 285* indicates the size of the structure. On extension of the thumb the band jumped out of the groove it had printed on the tendon—the intermittent symptoms were thus readily explained. The obstruction was excised by dividing it at the three attachments to the sheath. A probe was passed distally for an inch and no further obstruction was encountered. Extensor pollicis brevis may share a common canal with abductor pollicis longus at this point, but in this case the tendons had separate compartments. It was considered wise to inspect the adjacent sheath, but on slitting it open no abnormality was found. The abductor sheath was approximated with two fine catgut sutures; the abnormal sheath was left open. The skin was closed with silk sutures.

**POST-OPERATIVE COURSE**—Full movements were allowed two days after operation and were painless and free. The stitches were removed on the tenth day with primary healing. On Aug 18 the doctor who had originally submitted the patient wrote to say that the latter was completely satisfied with the result of operation and free from all symptoms.

**MICROSCOPICAL FINDINGS**—Microscopical examination of a cross-section of a Y-shaped fibrocartilaginous structure showed a reticulum of collagen fibres with cells interspersed and resembling normal tendon cells. The outer cells were somewhat flattened, but there was no true capsule or sheath. There was no evidence of inflammation and the appearance was of normal tendon.

## DISCUSSION

The interest in this case lies in the differential diagnosis. Not surprisingly, it was mistaken for stenosing tenovaginitis. The aetiology is uncertain, but the symmetrical appearance and the absence of thickening or adhesions in the adjacent sheath are against an inflammatory origin. The histology suggests a normal connective-tissue structure. The arrangement was not akin to that of the vinculae of tendons which carry vascular bundles and which occur more distally in the fingers and toes. A congenital origin is more likely and no reference to such has been traced in the literature available for study. The delayed onset of symptoms may have been due to a reactionary thickening of the structure induced by the unusual amount of writing done by the patient in recent months.

Treatment is surgical, with identification and removal of the constriction. Forcible manipulation might have snapped this structure and one might surmise that a few cases wrongly diagnosed as de Quervain's disease have been cured by such forcible methods.

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# AN UNUSUAL CASE OF SUPPURATIVE HEPATITIS DUE TO STREPTOCOCCUS VIRIDANS RECOVERY WITH PENICILLIN AND SULPHATHIAZOLE

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THE following case is thought worthy of record because it presents many points of interest to the clinician, the pathologist, and the bacteriologist.

## CASE REPORT

**HISTORY**—The patient, a tram conductress aged 26 at the time of the present admission, had already had a chequered career in hospital. Dyspepsia began at the age of 16, and a year later in 1936 she was treated for a gastric ulcer in a medical ward. Laparotomy was carried out in 1938, but the projected gastrectomy was abandoned because of the technical difficulty of dealing with a very high gastric ulcer which was penetrating the pancreas. She was re-admitted in 1939 with a severe hæmatemesis. A free perforation into the general peritoneal cavity was closed in January, 1945. She was re-admitted two months later because of severe and continuous pain. A high subtotal gastrectomy was performed on March 21, 1945. An operative detail, which appears important in retrospect, is that the ulcer crater (after cauterization with pure carbolic) was perforce left embedded in the pancreas. Convalescence was uneventful, and the patient returned to full work as a tram conductress after six weeks. She remained at full work for a further six weeks, free of all dyspepsia, and feeling splendidly fit till the onset of the present illness.

She was re-admitted (June 17) on the fifth day of illness. She said that on the first day she had felt nauseated when she awakened, but had gone to work.

At 10 o'clock pain in the back had begun "suddenly", but not so suddenly as on the occasion when the ulcer had perforated. The pain was at first across the loins and not very severe, but as the day went on the severity increased and the pain spread upwards over the lower ribs behind. Despite increasing pain and increasing nausea she persisted at work till the evening, when she yielded and went home, and later in the evening she vomited bilious material for the first time. Pain in the back and frequent vomiting continued till admission. Feverishness and sweating began on the second day of illness, but at no time did she have a rigor. On the third day she noticed a "lump" in the left hypochondrium, and this gradually enlarged.

**ON EXAMINATION**—On admission she was clearly desperately ill. She was flushed, sweating, writhing from side to side, and moaning with pain. The temperature was 103° F, and the pulse was 130 per minute, and of poor quality. On examination of the abdomen the most arresting feature was the presence of a visible tumour in the left hypochondrium the size of a grape-fruit. Its contours were smoothly rounded, and its central part was elevated about an inch above the general level of the abdomen. It occupied the whole of the left hypochondrium from the costal margin to the level of the umbilicus, and it transgressed the midline for an inch to the right. It moved freely on respiration. On palpation, the rounded margins were easily defined except above, where the tumour extended under the ribs. The tumour was of a uniform consistence, firm and elastic.

and tenderness was strikingly absent. As for the rest of the abdomen, respiratory movements were unrestricted and there was no muscular guarding. The right lobe of the liver was not palpable. Examination of the loins, which the patient indicated as the site of pain, revealed neither tenderness nor guarding, and there was no tumidity.

The correct diagnosis was not made. It was clear that the patient was desperately ill from an inflammatory lesion, and it was conjectured that a localized abscess had formed as the result of perforation of an anastomotic ulcer which was walled off by adhesions. Laparotomy was carried out with the object of draining the abscess.

**LAPAROTOMY (June 17)**—The tumour was found to be the grossly enlarged left lobe of the liver. Visible beneath the serous covering was an uncountable multitude of abscesses each the size of a pin's head. The right lobe of the liver was also enlarged, but not so grossly as the left. It could not be freely inspected because of numerous adhesions. These were successively divided

# DOSAGE OF PENICILLIN AND SULPHONAMIDE—

## a Penicillin—

	By Intramuscular Drip continuously, over Each 24-hour Period	By Intravenous Drip, Each Dose given over a 4- to 5-hour Period
1st day	400,000 units	500,000 and 500,000 units
2nd day	400,000 units	500,000 and 500,000 units
3rd day	200,000 units	500,000 units
4th day	200,000 units	500,000 units
5th-20 days	400,000 units	(None)

Total penicillin about 10,000,000 units

**b Sulphonamide**—During the first 24 hours, 20 c of soluseptasine were given intravenously every six hours. Thereafter, this was replaced by sulphathiazole by mouth, the dosage being 2 g at 6 a.m. followed by 1 g four-hourly till 10 p.m., none of the drug being given at night. This was continued till the sixteenth day, a total of some 90 g being administered.

A check was kept on the bacteriostatic activity of the blood against the standard Oxford strain of *Staph aureus*.

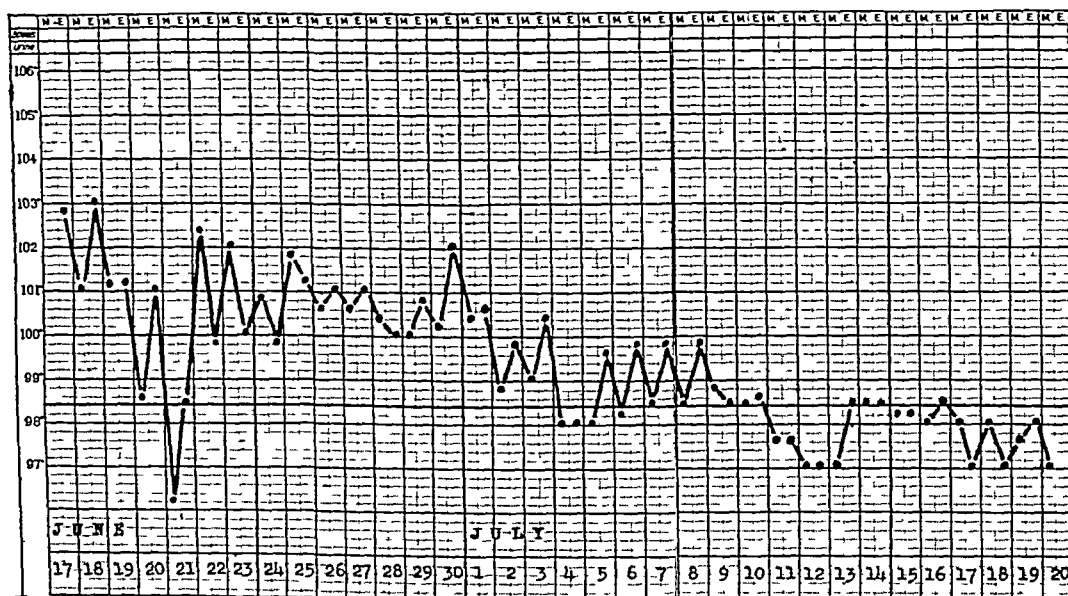


FIG 286—Axillary temperature-chart from admission on fifth day

until the right lobe had been inspected for a distance of about an inch to the right of the gall-bladder. All surfaces of the left and right lobes so exposed were closely beset with miliary abscesses. The liver substance between the abscesses were engorged with blood and plum-coloured. Despite the risk of severe hæmorrhage, a deep section of the left lobe was removed for biopsy. Hæmorrhage was profuse, and could be only partially controlled by a gauze pack, round which the wound was closed.

Inspection of the slice of liver removed for biopsy showed at once that closely-set abscesses, each oozing a bead of pus, were scattered throughout the depth of the section. Examination of the pus revealed the presence of many streptococci, present in short chains up to 6 or 8 cocci.

At this time the chance of recovery appeared to be very slight. The only possibility of effective treatment seemed to lie in heavy dosage with penicillin reinforced with sulphonamide. Accordingly the administration of penicillin was begun at once without waiting to verify that the organism was penicillin-sensitive.

The bacteriostatic activity was disappointingly low, considering the high dosage of penicillin. The following values are representative—

- 1 Evening of fourth day total inhibition 1 1  
partial inhibition 1 2  
(The dosage was for this reason increased on the fifth day)
- 2 Fifth day total inhibition 1 2  
partial inhibition 1 4
- 3 Eighth day total inhibition 1 1  
partial inhibition 1 4

Blood-culture on the fifth day was sterile.

**PROGRESS**—Recovery was slow, but progress was steadily maintained. Thus the temperature fell by gradual lysis over a period of three weeks (Fig 286). Slight improvement in the general condition was noted on the third day, and on the fifth day the patient began to take an interest in her surroundings. Her appetite returned at the end of a week and she began to take light diet. After three weeks she was eating well and sleeping without sedatives. She was allowed home on the

twenty-ninth day A few of the details of her convalescence are of sufficient interest to be recorded

Vomiting continued during the first four days, becoming progressively less troublesome During this period intravenous saline and glucose had been given, but were stopped on the fourth day that evening it was noted that there was a little œdema of the ankles During the next few days her thirst was unquenchable, and she drank

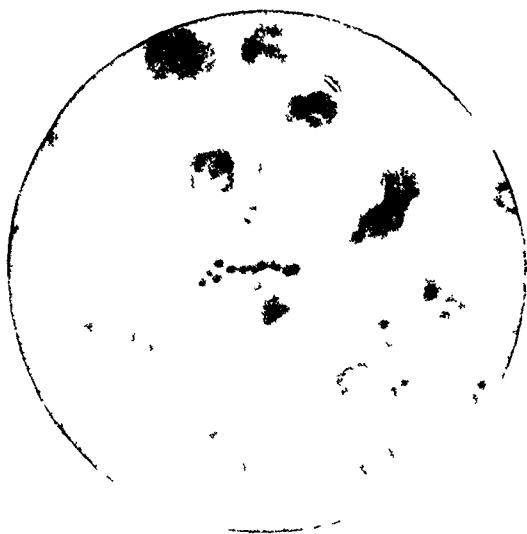


FIG 287—Section cut from fixed tissue, stained by Gram's method, to show the streptococcus ( $\times 2300$ )



FIG 288—Masson's stain Showing the great number of minute abscesses, each surrounded by a darkly stained ring of fibrinous exudate ( $\times 15$ )

copiously On the fifth and sixth days she developed gross œdema of both legs, and a gross acute ascites During the next fortnight the œdema and ascites gradually diminished, and at the time of her discharge from hospital there was no more than the slightest pitting on pressure above the ankles

Pain across the loins remained troublesome during the first ten days On the tenth day she complained for the first time of pain in the left hypochondrium This lasted for only a few days, and by the seventeenth day all pain ceased

At no time was the patient jaundiced, and it is noteworthy that throughout the illness rigors were absent, save following two abortive attempts to give a transfusion of blood

**SOURCE OF INFECTION**—The source of the infection remains unproved, but there appears to be good reason to incriminate the floor of the gastric ulcer (which, it will be remembered, was left embedded in the pancreas at gastrectomy three months previously) It is unlikely that the organism reached the liver by the bile-ducts or by the hepatic artery Thus an ascending biliary infection is improbable in the absence of any history suggesting cholecystitis and in view of the fact that a normally functioning gall-bladder has since been demonstrated by a cholecystogram series Again, if the infection had originated in a dental abscess or an endocardial vegetation and had reached the liver by the systemic circulation, some manifestation of infection of other organs might have been expected But at no time were there painful subcutaneous nodes, nor were red blood-cells to be found in the urine on repeated examinations Furthermore, it is difficult to conceive of a systemic septicæmia heavy enough to give rise to such countless numbers of minute abscesses which by their uniform size indicated a common age Indeed, rupture of an abscess into a tributary of the portal vein seems to be the only plausible explanation and such an abscess might well have been present in the pancreas, originating in the embedded gastric ulcer

**NATURE OF THE ORGANISM**—In direct smears of the pus from the biopsy specimen, and in actual stained sections (see Fig 287) the only organism seen was a streptococcus occurring in chains of 6-8 cocci This organism on culture gave a pure growth of *Str viridans*, exhibiting the classical properties of that organism Thus it proved to be an aerobe, producing green pigment on human or horse blood, and dark-green pigment on chocolate agar It produced acid in lactose, glucose, sucrose, and inulin, and acid and clot in milk It did not ferment mannite and it did not survive heating at



FIG 289—Masson's stain Showing an abscess with surrounding fibrinous exudate on the right, and increased cellularity of two portal tracts on the left ( $\times 60$ )

$56^{\circ}$  C for 30 minutes these features eliminate any possibility of confusion with an atypical strain of the enterococcus group The organism was shown to be penicillin-sensitive

It is a matter for comment that this organism, whose aggressiveness is of a low order, should as an unmixed infection invade healthy vascular tissue and be strongly pyogenic The organism is common in such mixed infections as dental or tubo-ovarian abscesses, but when it occurs alone as in endocarditis or in meningitis the formation of pus is either absent or scanty Perhaps the explanation of its behaviour in the present case lies in the mode of origin of the infection The postulated origin by rupture of an abscess into the portal stream might give rise to such an overwhelmingly heavy infection

that even an organism of low aggressiveness might be able to establish itself

**HISTOLOGY**—The appearance of the stained sections is the abscesses separated by narrow bands of compressed liver cells. Fig 288 illustrates a field representative of the whole section. It is indeed remarkable that a liver whose structure is so extensively disorganized could support life, and be compatible with a return to abounding health. The section has been stained by Masson's method to show the ring of fibrin surrounding the abscesses. Fig 289 illustrates the appearance at a magnification of  $\times 60$ , and in addition to one frank abscess shows aggregation of polymorph leucocytes round the portal systems.

**LIVER FUNCTION**—It was apparent that observations on hepatic function would be of interest, and the tests carried out are shown in the following table

	JUNE 22	JULY 11	AUG 17	OCT 9
Plasma bilirubin (mg per cent)	0.5	0.2	0.2	0.2
Glucose tolerance	Normal	—	—	—
Lævulose tolerance	Abnormal	High normal	Abnormal	Normal
Cephalin flocculation	+++	+++	++	Negative
Albumin (g per 100 ml of plasma)	2.68	3.76	4.14	4.63
Globulin (g per 100 ml of plasma)	2.43	3.62	2.49	2.21
Fibrinogen (g per 100 ml of plasma)	0.50	0.46	0.32	0.32
Total protein (g per 100 ml of plasma)	5.61	7.84	6.95	7.16
Packed cell volume (per cent)	22.0	31.8	34.0	—

It is noteworthy that the plasma-bilirubin level was at no time above normal. Glucose tolerance estimated on June 22 showed no abnormality. The lævulose tolerance tests, interpreted according to Rennie (1943), suggest impairment of liver function on the first three occasions of testing. The cephalin flocculation test, introduced by Hangar (1939) has been chiefly used to detect damage to the liver parenchyma. flocculation (i.e., a positive result) was present on the first three occasions, but absent on the last.

The alterations in the plasma-protein levels are somewhat difficult to interpret. Disease of the hepatic parenchyma and infective processes are alike associated with a fall in plasma-albumin and a rise in plasma-globulin. In this patient when suppuration was present actually in the liver, pronounced alterations would be expected. Lowered albumin and raised globulin values were indeed present on July 11, but not on the first occasion, when the albumin was low but the globulin level appeared to be normal. Probably both estimates on this occasion were fictitiously low because of the hæmodilution (evidenced by the low packed cell volume) which accompanied the oedema already noted at this time. The third and fourth estimations show that the albumin and globulin levels gradually returned to normal.

**LATER PROGRESS AND PROGNOSIS**—After discharge from hospital the patient continued to make good progress. She returned for examination on Aug 17 (three months after the onset of suppurative hepatitis). She reported that she was in excellent health and was free from indigestion. She looked a normal young woman, and had acquired a healthy layer of subcutaneous fat. No abnormality was detected on examination, and the liver was not enlarged. She returned to work as a tram conductress at the end of August, and in January, 1946, was still continuously at work and in excellent health.

It was feared, at the time the patient left hospital, that contracture of scar tissue in the liver might lead to obstruction of the portal circulation and ascites. Full health and normal hepatic function tests have, however, been maintained for seven months, and it now appears safe to conclude that recovery is to be complete.

It is a pleasure to express my gratitude to Professor Illingworth for his stimulating interest in this case and to Doctors Rennie, Lominski, and Trounson of the Departments of Medicine, Bacteriology, and Pathology for their technical reports and valuable suggestions. I am further indebted to Dr Trounson for the illustrative microphotographs.

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# CASE OF LYMPHANGIOMA IN THE REGION OF THE HEAD OF THE PANCREAS CAUSING AN OBSTRUCTIVE JAUNDICE

By H. W. PORTER

ASSOCIATE ASSISTANT SURGEON, CHALMERS HOSPITAL, EDINBURGH

A CASE of obstructive jaundice simulating carcinoma of the head of the pancreas clinically but caused by an unusual simple tumour is described.

## CASE REPORT

The patient, Mr. R., aged 66, was admitted to Chalmers Hospital on Sept. 6, 1941. On admission, the patient was deeply jaundiced, rather cachectic, and had obviously lost a great deal of weight. He thought that he had been losing weight for about five months, and he had also suffered from a little flatulence, loss of appetite, and heartburn, but had had no sickness or pain. A fortnight before admission his doctor noticed that he was jaundiced. This became progressively more severe.

**ON EXAMINATION**—There was a large palpable gall-bladder, and below this a large, firm, palpable tumour. The patient was such a typical case of carcinoma of the head of the pancreas so far advanced that we very nearly considered leaving him alone. He was, however, very miserable and had a great deal of itch and discomfort, and in view of this it was decided to carry out some palliative procedure.

**AT OPERATION**—The gall-bladder was found to be very distended and there was a large tumour about the size of a cricket ball in the region of the head of the pancreas. This did not have quite the stony-hard feeling of a carcinoma, nor could any secondaries be felt. A small piece was taken for biopsy and a cholecyst-gastrostomy was performed.

The patient's jaundice immediately began to improve and his general condition became better. The section

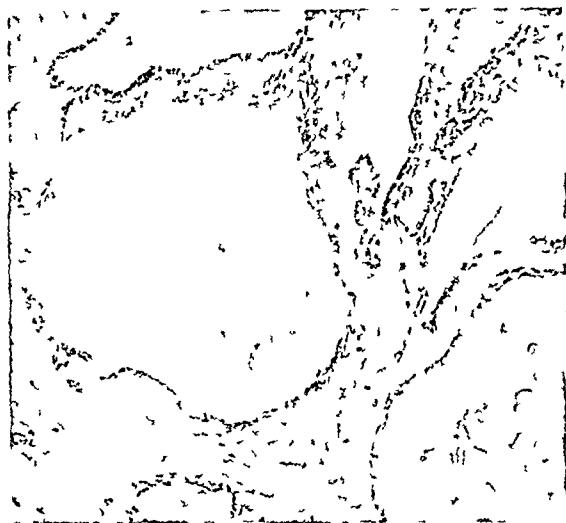


FIG 290—Section of tumour

of the tumour (Fig 290) showed a lymphangioma with multilocular cavernous spaces and endothelial lining, and there was some perivascular endothelial increase with no inflammatory reaction. There was no evidence of malignancy. Since excision of the tumour would have been exceedingly hazardous, it was decided to treat it with deep X-ray therapy.

Deep X-ray therapy was administered by Dr McWhurter, Royal Infirmary, Edinburgh, from Dec 4 to Feb 16, 1942, the dose being 3000 r.

The patient progressively improved from the time of his operation, and as it was rather difficult to assess the value of the X-ray therapy, a barium meal was given before the treatment. Fig 291 shows the state of affairs on Nov 6, 1941. It will be noticed that there is very marked broadening of the D of the duodenum, the first part being pushed upwards and the third part downwards by the tumour. A subsequent barium meal (Fig 292) carried out on Nov 27, 1945, shows the duodenum to have returned to its normal position and barium can be seen entering the gall-bladder.

Since his operation and treatment, the patient has continued to be in good health.



FIG 291—Radiograph following a barium meal, showing condition on Nov 6, 1941. Marked broadening of D of duodenum and change of position: the first part being pushed upwards, the third part downwards by the tumour.



FIG 292—The appearance on Nov 27, 1945, showing the return of the duodenum to its normal position.

## A CASE OF A CHRONIC VOLVULUS OF THE JEJUNUM DUE TO MULTIPLE JEJUNAL DIVERTICULA

By H W PORTER

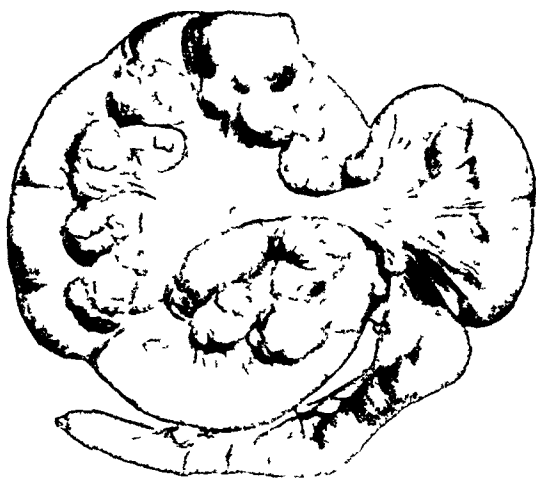
ASSOCIATE ASSISTANT SURGEON, CHALMERS HOSPITAL, EDINBURGH

WHILE diverticula of the jejunum and ileum are not exceedingly rare conditions, especially of the jejunum, it is unusual for them to give rise to symptoms, and it is thought that it might be of interest to record a case with a chronic volvulus. The complications associated with diverticula of the jejunum may

be (1) Inflammatory disturbances giving rise to perforation, (2) Occasional intestinal hæmorrhage, (3) Rupture, which may be spontaneous or traumatic, (4) Foreign bodies causing perforation, (5) Neoplasms or neoplastic disease which occasionally takes place in the diverticula, (6) Acute intestinal

obstruction or sometimes, but rarely, chronic intestinal obstruction. Complications arising from diverticulosis of the jejunum are uncommon. Dickson and Waugh (1943) described symptoms in only 13 of 122 cases recorded at the Mayo Clinic

July, 1945, three weeks before his second admission to hospital, he had a sudden attack of abdominal pain, nausea, and vomiting, and on this occasion the vomitus was quite definitely dark in colour. Immediately after this, he had a recurrence of his old symptoms, intermittent



FIGS 293, 294—The portion of jejunum resected, showing the twisted loops and the numerous diverticula

Walker (1945) states that volvulus causing acute intestinal obstruction has only been recorded twice, but records no case of chronic volvulus.

A case of chronic intestinal obstruction due to a chronic volvulus associated with diverticulosis of the jejunum is described.

### CASE REPORT

**HISTORY**—The patient, a male aged 64, was admitted to Chalmers Hospital in August, 1944, complaining of pain in the umbilical and epigastric regions, from which he had been suffering periodically for two years. The pain at that time was colicky in nature. Though sometimes very severe, it was relieved with antispasmodics, and latterly it had become increasingly worse and the patient began to complain of waterbrash and heart-burn. Vomiting became more frequent, until he was vomiting every 24 hours. The vomiting was sometimes induced by himself in order to relieve flatulence, and the vomitus occasionally contained a little blood. The patient's pain became worse immediately after meals and was sometimes relieved by lying down. He was admitted to hospital and a barium series was rather inconclusive and showed rather a large stomach and a slight deformity of the duodenal cap. There was no evidence in the barium series of diverticulosis. The patient had a high rising gastric acidity and he was treated medically with diet and rest in bed. With this he improved considerably and was discharged. He remained well except for occasional bouts of colic and distension until July, 1945, and put on weight.

During the intervening period he was considerably constipated and for this he took a regular aperient. In

colicky pain, repeated vomiting, loss of weight, flatulence, and a degree of constipation. He was re-admitted to hospital and a further barium meal again revealed no definite peptic ulcer, nor did it show any abnormality in the small intestine. His test-meal again showed rather a high acid value, he had occult blood in his stool, and there was considerable loss of weight. Since he was not responding to medical treatment, it was decided to perform a laparotomy.

**AT OPERATION**—The stomach was found to be rather distended and there was some scarring at the pylorus, with a small posterior duodenal ulcer, and it was decided to do a posterior gastro-jejunostomy. On seeking the jejunum, it was found that the first two loops were distended, hypertrophied, and had an exceedingly long mesentery. Both loops were twisted through 180° on the mesentery and were the site of numerous diverticula. The diverticula started about 4 in. below the duodenojejunal junction, were largest at the upper end, and then gradually tailed off, and about 3 ft. farther down the jejunum became normal. No diverticula were found in the ileum, colon, or duodenum. The affected portion of jejunum was resected and an end-to-end anastomosis performed, following which a posterior iso-peristaltic gastrojejunostomy was carried out (Figs 293, 294).

The patient had an uneventful convalescence and has had complete relief from his symptoms.

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## AN UNUSUAL CASE OF SHARK-BITE

By ERIC DAVIES

SURGEON, ANGLO-IRANIAN OIL CO., LTD

NINE cases of shark-bite have been operated upon during the last two years, of which 7 were partial or complete amputations of arm or leg

The ninth case is reported in detail as it is unusual and illustrates the remarkable protective functions of the omentum

## CASE REPORT

**HISTORY**—The patient, an Arab woman of 30, was a passenger on a dhow which was wrecked at the head of the Persian Gulf. She had been holding on to a piece of floating wreckage for an hour when she was attacked by a shark, which wounded her in the abdomen but did

grey in colour, and gurgling sounds could be obtained by pressure (*Figs 295, 296*). There was slight guarding in the vicinity of the wound, but the remainder of the abdomen was quite soft and there was no distension or shifting dullness. There was no tenderness on rectal examination.

**OPERATION**—The surface of the mass was cleaned with saline and a line of cleavage found which made easy the division of the wall. This consisted of omentum quite  $\frac{1}{2}$  in thick and contained a loop of transverse colon covered by smooth shining peritoneum. The outer surface of the omental sac was separated from the tissues of the abdominal wall by gauze dissection and slight traction applied so that the extra-abdominal portion could be resected after securing the vessels by multiple



FIGS 295, 296—Photographs of patient, showing site and extent of abdominal protrusion

not succeed in pulling her down. She was in the water for a further four hours and was then rescued and put ashore at a small Arab village. The rescue work was directed by an English pilot who was under my care some months later and was able to verify the times and dates, and from whom it was learnt that over 40 persons were lost in the wreck, mostly due to sharks.

The patient remained in the village for five days, during which time the mass on her abdomen was kept covered by a damp cloth. As she showed no signs of dying the inhabitants brought her to Abadan in a lorry, the journey taking 24 hours owing to a breakdown in the desert.

**ON EXAMINATION**—She was a fit-looking woman much decorated with tattoo marks and bracelets. Her temperature was  $98.4^{\circ}$  and pulse 72, her tongue was clean, and she had not vomited. Her bowels had acted once since the accident. On the left side of the abdomen was a large mass protruding through a transverse wound in the abdominal wall, it being quite soft and pearly

ligatures. The bowel could then be replaced through the wound, which was found to be  $4\frac{1}{2}$  in long at the skin level and  $2\frac{1}{2}$  in at the peritoneum. Part of the adjoining descending colon could be seen and showed no signs of bruising and there was no adherent small intestine. A corrugated rubber drain was inserted through the wound, which was closed by all-layer sutures.

**PROGRESS**—The drain was removed after 24 hours and the wound healed well, her recovery being uneventful. She was free of symptoms when seen one month later and there was no weakness at the site of the bite.

**Comment**—It seems remarkable that a wound of this size could be caused by a shark's tooth without causing visceral damage. It is also interesting to speculate whether the four hours' immersion in sea water was a factor in producing the complete covering of omentum.

## REVIEWS AND NOTICES OF BOOKS

**Regional Analgesia** By H W L MOLESWORTH, FRCS (Eng.), Senior Surgeon, Royal Victoria Hospital, Folkestone. Second edition  $8\frac{1}{2} \times 5$  in Pp 92 + viii, with 42 illustrations. 1946. London H K Lewis & Co Ltd. 8s 6d net.

FIRST published in 1940, the second edition of this small book contains few alterations or additions, and remains an excellent account of the personal experiences of the author in the use of regional analgesia.

The text is well arranged and interesting to read, and the numerous illustrations are well produced and achieve their object.

**Modern Anaesthetic Practice** *The Practitioner Handbooks*. Edited by the late Sir HUMPHREY ROLLESTON, Bt, G CVO, KCB, MD, FRCP, and ALAN MONCRIEFF, MD, FRCP. Second edition  $8\frac{1}{2} \times 5\frac{1}{2}$  in Pp 150 + viii, with 7 illustrations. 1946. Eyre & Spottiswoode (Publishers) Ltd, for *The Practitioner*. 12s 6d net.

In the editorial preface to the second edition we read "Those in general practice are constantly being required to give anaesthetics, and it is for them rather than for the specialist-expert that this book was planned and for whom, once again, the second edition is intended. If it continues to be found of value then it is to the skilled contributors that thanks are due, and editorial gratitude must be added for their cheerful co-operation, suggestions, and advice."

In our opinion the objects of this book have been largely achieved, for it contains a wealth of information and the contributions are well arranged and form a genuine synopsis of modern anaesthetic practice.

At a time when the ever-increasing mechanization of practical anaesthesia is receiving a good deal of criticism, it is interesting to read the comments of Dr John Gillies at the commencement of Chapter II "The volatile anaesthetic drugs still form the main stock in trade of the occasional or less experienced anaesthetist. No elaborate equipment is necessary for their application and therefore in this respect they are simple as well as convenient and portable. The anaesthetist should appreciate, however, that the advantages just mentioned accrue to himself rather than to the patient, and that in simple technique there are undesirable features which he must always keep in mind and which it is the purpose of modern apparatus to eliminate, or at least to modify."

In Chapter IV, on Basal Narcotics, we note that in the discussion on complications of pentothal no mention is made of the use of picrotoxin, or the dangers of intra-arterial injection. This last complication is a catastrophe, and every occasional anaesthetist should be instructed how to avoid it.

In Chapter VII, on Anaesthesia and Analgesia in Midwifery, the contributor goes out of his way to emphasize the value of chloroform in domiciliary obstetrics, and endeavours to make a case for the continued use of this drug. In fact, he deplores the lack of routine instruction in teaching hospitals, and even attempts an analogy to road mortality. He writes "Speed in itself may be dangerous, but it is not speed alone which kills, but impatience and lack of due care and attention. Speed in the wrong place kills, so do the various anaesthetic agents. The need is to learn where those wrong places are."

In our opinion this contributor is defending and advocating a lost cause, and we consider the views of Dr Paluel Flagg, published in a recent text-book, to be a much better expression of contemporary obstetric

and anaesthetic opinion. Flagg writes "Chloroform, while ideal in efficiency, is a dangerous poison. In the light of present-day pathology, chloroform should cease to be used as an anaesthetic in obstetrics."

This book is well produced, the illustrations are clear and adequate, and the volume should continue to be a popular contribution to the "Practitioner Handbook" library.

**The Care of the Neurosurgical Patient** Before, During, and After Operation. By ERNEST SACHS, A B, MD, Professor of Clinical Neurological Surgery, Washington University School of Medicine, Saint Louis.  $9\frac{1}{2} \times 6\frac{1}{2}$  in Pp 268, with 177 illustrations. 1945. London. Henry Kimpton. 30s net.

THIS is an important book which deals with an important subject. Professor Sachs's extensive and ripe experience is set out in a most interesting and fascinating manner. In this monograph the important points dealing with the care of the neurosurgical patient before, during, and after operation are given in a very practical way.

The numerous illustrations are of great help to the reader and enhance the value of the book.

The various neurosurgical methods used by the author are the outcome of a life-long study of this branch of surgery and are ones which have stood the test of time.

Neurosurgeons the world over will read this book with interest and profit.

**The Anatomy of the Bronchial Tree** With Special Reference to the Surgery of Lung Abscess. By R C BROCK, M S (Lond), FRCS (Eng.), Surgeon to Guy's Hospital, Surgeon to the Brompton Hospital, Surgeon to an E M S Thoracic Surgical Centre.  $9\frac{1}{2} \times 6$  in Pp 96 + vi, with 142 illustrations, many as plates. 1946. London. Geoffrey Cumberlege, Oxford University Press. 42s net.

THIS monograph is in reality a reprint of an excellent series of articles published in the *Guy's Hospital Reports* during recent years. The advent of bronchoscopy and modern X-ray pictures has added enormously to our knowledge of the anatomy of the bronchial tree, and Mr. Brock has increased our understanding in the surgery of lung abscess.

This book will prove of real value, not only to surgeons and physicians who are interested in the diseases of the chest, but also to anatomists and physiologists.

The illustrations throughout the book are of a high order of perfection.

**Anatomical Eponyms** Being a Biographical Dictionary of those Anatomists whose Names have become incorporated into Anatomical Nomenclature, with Definitions of the Structures to which their Names have been attached and References to the Works in which they are described. By JESSIE DOBSON, B A, M Sc. With a Foreword by Professor F WOOD JONES.  $8\frac{1}{2} \times 6\frac{1}{2}$  in Pp 240 + x, with Frontispiece. 1946. London. Bailliere, Tindall & Cox. 30s net.

RECENT standardization of anatomical nomenclature has resulted in suppressing or limiting the traditional and, on the whole, desirable custom of linking the names of the original workers with the anatomical structures which they discovered. Apparently in Great Britain—says the author—we are now committed to a system of anatomical terminology from which all eponymous nomenclature has been removed.



This does seem a pity, and so unnecessary. The author apparently feels it so strongly as to justify this biographical dictionary of those anatomists whose names have become associated with certain structures. The book, which is beautifully got up, has a Foreword by Professor Wood Jones and a Frontispiece of Vesalius. It is a very useful book of reference.

**Patients and Appendicitis** By Sir CRISP ENGLISH, KCMG, FRCS, Consulting Surgeon, St George's Hospital, Hon Consulting Surgeon, Queen Alexandra's Military Hospital, Millbank, etc.  $8\frac{3}{4} \times 5\frac{1}{2}$  in Pp 155 + vii 1946 London J & A Churchill Ltd 10s 6d

THIS is an interesting little monograph which is full of sound surgical common sense and it deals with a somewhat neglected subject.

How often the patient is neglected and not taken into account by the doctor or surgeon concerned when the question of operation for appendicitis is considered.

Sir Crisp has drawn from his matured and extensive clinical experience and acumen in the writing of this book. It should prove of value, not only to the practitioner, but also to the student, who will learn more from this little book about appendicitis than he will from the average text-book on surgery.

A concise, up-to-date, and useful bibliography on appendicitis is given at the end of the volume.

**Manual of Diagnosis and Management of Peripheral Nerve Injuries** By ROBERT A GROFF, M D, and SARA JANE HOUTZ, B S. With an Introduction by I S RAVDIN, M D.  $8\frac{1}{2} \times 6$  in Pp 188 + xii, with 111 illustrations. 1946 Philadelphia and London J B Lippincott Co 36s net

THIS is a practical little monograph which gives a new approach to the diagnosis, management, and after-care of peripheral nerve injuries.

The book is divided into two parts. Part I is devoted to a general discussion of nerve injuries, with specific advice on how to recognize immediately, and manage effectively, injuries affecting the peripheral nerves. Part 2 presents an illustrated outline of peripheral and cranial nerve function. Muscle function is shown effectively by action diagrams.

There are over a hundred illustrations, quite a number of which are original and most instructive.

There are a few mistakes which require correction—on page 136, the deep peroneal nerve is stated to supply the interossei, which is quite wrong.

The book should prove of value to general practitioners, surgeons and neurosurgeons, and physiotherapists who require a quick reference book which can be used in the out-patient department or ward.

**Penicillin Its Practical Application Under the General Editorship of Professor Sir ALEXANDER FLEMING, M B, B S, FRCP, FRCS, FR S,** Professor of Bacteriology in the University of London, St Mary's Hospital, London.  $8\frac{1}{2} \times 5\frac{1}{2}$  in Pp 380 + vi, with 59 illustrations. 1946 London Butterworth & Co (Publishers) Ltd 30s net

ALTHOUGH much has been written concerning penicillin during the last three years, yet there is room for this volume. Sir Alexander Fleming, who is the general editor and has written about the history and development of penicillin, and the bacteriological control of penicillin therapy, has collected a band of expert clinicians who have written concise practical articles dealing with their specialties. Porritt and Mitchell have contributed a well-balanced article on the prophylactic use of penicillin and quite rightly emphasize the important fact that

penicillin does not replace surgery. Vaughan Hudson writes on generalized infections and reports some interesting clinical cases which were treated with penicillin. Hope Gosse deals with chest infections, while Holmes Sellors contributes a chapter on Chest Surgery. Dickson Wright has written an excellent chapter on the value of penicillin in infections of the brain, while McElligott deals with the problems of venereal diseases.

The book is an important one, as it gives the latest practical details of penicillin therapy. No surgeon can afford to be without this really useful book.

**Pathology in Surgery** By N CHANDLER FOOT, M D, Professor of Surgical Pathology, Cornell University Medical College, Surgical Pathologist, New York Hospital.  $10 \times 6\frac{1}{2}$  in Pp 511 + xi, with 368 illustrations in text and 11 coloured plates. 1946 Philadelphia and London J B Lippincott Co 60s

THIS is a book on surgical pathology written by a pathologist, and, when all is said and done, this is the right type of author. Some members of the profession consider that a book on surgical pathology should be written by a surgeon, but Professor Foot has easily refuted this idea by the publication of this book. He establishes the significant place occupied by pathology in surgery, and draws a precise boundary between it and pathology in general.

The book is profusely illustrated with some 400 microphotographs and some coloured photographs. The microphotographs are excellent, they are clear and well reproduced, but it is a pity that the magnification is not given in each case. Surgical pathology to-day covers a vast field and this book includes the cardiovascular system, blood-forming organs, respiratory system, alimentary tract, liver, gall-bladder, pancreas, urinary system, organs of internal secretion, the breast, nervous system, and male and female reproductive system.

There can be no doubt that this book will prove of real value to surgeons who require a reference volume on surgical pathology.

**The Principles and Practice of War Surgery** With Special Reference to the Biological Method of Treatment of Wounds and Fractures. By J TRUETA, M D, Hon D Sc (Oxon), Surgeon (E M S), Wingfield-Morris Orthopaedic Hospital, Oxford, Acting Surgeon-in-Charge, Accident Service, Radcliffe Infirmary, Oxford, Formerly Director of Surgery, General Hospital of Catalonia, University of Barcelona. Third edition, revised and enlarged.  $9\frac{1}{2} \times 6\frac{1}{2}$  in Pp 426 + xvii, with 156 illustrations. 1946 London William Heinemann Medical Books Ltd 42s net

THAT a third edition of this book is required only three years after the publication of the first edition is evidence enough of its popularity and usefulness. Although we are back to times of peace, yet it is an era of mechanical transport, with its heavy toll of accidents causing lacerated injuries to children and adults alike, and the principles set out in this volume will be of value to the practitioner and surgeon who will have to deal with the civilian casualties.

Like its predecessors, this third edition is concerned in large part with those methods (i.e., wound excision and the complete encasement of wounded limbs in plaster) which are now generally associated with the author's name.

The book is well illustrated with excellent photographs and drawings, many of which help to elucidate the text. It will retain its place as an authoritative reference work.

**The Management of Fractures, Dislocations, and Sprains** By JOHN ALBERT KEY, B.S., M.D., St. Louis, Wis., and H. EARLE CONWELL, M.D., F.A.C.S., Birmingham, Ala. Fourth edition 9½ x 6½ in Pp 1322, with 1316 illustrations 1946 London Henry Kimpton 63s net

THE fourth edition of this well-known book on fractures has been carefully revised and brought up to date. War surgery has had something to give to orthopaedic practice and this book contains the new methods in vogue at the present time for the treatment of compound fractures.

Skeletal traction is given its proper place in the treatment of fractures, and the danger of distraction is rightly emphasized. Perhaps the greatest advance that has been made is in the treatment of fractures of the jaw and face, as much has been learnt from the numerous cases which occurred during the recent world war.

This book is profusely illustrated with some 1310 clinical, radiological, and line drawings, but it is a pity that some of the older illustrations have not been replaced, as they are rather indistinct.

This volume still maintains its place as a reference volume dealing with traumatic surgery of the skeleton.

**Penicillin in General Practice** By J. L. HAMILTON-PATERSON, M.D., Pathologist to Redhill County Hospital, Edgware 6½ x 4 in Pp 95, with 10 illustrations 1946 London Staples Press Ltd 5s net

THIS compact little volume would seem to have everything to recommend it. It is of handy size (to fit the pocket), well produced, cheap (at five shillings), and contains in its ninety-odd pages a wealth of clearly set out, practical information on a subject a more than cursory knowledge of which is quite reasonably to-day demanded by the patient of his doctor. The author, a pathologist, might be expected to stress the more scientific side of the subject, but while this receives very adequate consideration, it is obvious from a perusal of the book that Dr. Hamilton-Paterson must have had very considerable personal clinical experience of his subject-matter. In the first half of the book he deals with the properties, nature, and principles governing administration of penicillin, in the second half, with lines of treatment for various individual disorders. This latter half is remarkably comprehensive and includes brief chapters on the use of penicillin in venereal disease and the common dermatological, ENT, and eye diseases. Two good points are made—and remade—throughout the book. The first is that without suitable bacteriological control penicillin administration—now in the hands of such a vastly enlarged field—will easily fall into disrepute and lose that sound scientific basis on which its use was developed, and secondly that penicillin therapy cannot replace sound surgery where such is indicated, i.e., that dead tissue of all kinds is still inaccessible to penicillin and requires removal.

It is stated (pp 16, 24) that synovial membranes of the larger joints form an impermeable barrier to the passage of systemic penicillin. Recent researches (Penicillin Therapy and Control, 21 Army Group) prove this is not the case, as sufficiently large parenteral dosage does produce easily recognizable penicillin concentration in the synovial fluid. The point is of minor practical importance, however, as local instillation into the joint cavity, as recommended by the author, is undoubtedly both more efficient and more economical. The chapter on the principles of treatment is eminently practical and the brief discussion on the time-dosage relationship is particularly to the point. It is to be hoped that the term a "course of penicillin" will not be allowed to creep into common usage. The only direction in which the book might be said to exceed its stipulated scope, and

this perhaps a forgivable licence to a pathologist, is in the rather full discussion (and diagrams) of the somewhat cumbersome Eudrip apparatus and the complicated electric motor for systemic administration. These require adjustment and attention beyond the power or time of the average general practitioner, and mention might well be made of the use of the much simpler blood-transfusion bottle—to say nothing of a word on the value of the intelligent patient's co-operation during his waking hours in watching the drip-chamber.

But these are small criticisms of a most informative and accurate little book—one which it is felt will deservedly be most popular with those for whom it was primarily written, the general practitioners. Its field might with value be far more widely extended!

**The Surgical Clinics of North America** Chicago Number, February, 1946 Symposium on Surgical Technic 9 x 6 in Pp 269 + vi, with 172 illustrations London and Philadelphia W B Saunders Co Annual subscription (six numbers), paper 55s, cloth 75s

THIS symposium on colon surgery is really the contents of the June, 1946, number of the *Surgical Clinics of North America*. Every aspect of colon surgery is discussed in the several interesting papers which go to make up this volume. The treatment of ulcerative colitis is given in a very comprehensive fashion, but the results in America do not seem any better than in this country.

The references are solely American.

**Journal of the History of Medicine and Allied Sciences** Edited by GEORGE ROSEN Volume I, Number 1, January, 1946 10 x 6½ in Pp 183, illustrated New York Henry Schuman Quarterly \$8 50, single copies, \$2 50

THE appearance of a new journal on the history of medicine, in the English language, must be regarded as a major event and commented on with care.

It is a matter for regret that the *Annals of the History of Medicine*, edited by Dr. Packard, became a war casualty and will not be revived. This new journal takes its place.

It may be wondered whether there is room for another similar publication alongside the *Bulletin of the History of Medicine*, edited by Professor Henry Sigerist. On this point it is stated that the policy of the new journal is that it will not compete with the *Bulletin*, but will supplement it.

The Editor of the new journal is Dr. George Rosen. He has written a first-class treatise on "The History of Miners' Diseases", and is reputed to be a first-class scholar. He says, in his introduction "We do not want to cultivate medical history as a search for antiquities, as a hunt for curios, but rather as a vital, integral part of medicine. We believe that this can be done." Yes. So do we! But we would like to say, very humbly, that the medical profession needs some coaxing to take any real interest in the history of our profession and that the process of instruction should not be too devastatingly dull.

This first volume contains 183 pages, with a number of illustrations, and among the ten or more subjects are A substantial contribution by Professor Charles Singer on "Some Galenic and Animal Sources of Vesalius", "The London Years of Benjamin Waterhouse", by J. C. Trent, and "A Note on William Blake and John Hunter", by Jane Oppenheimer. The publisher is Henry Schuman, of New York, a publisher of sound repute, who has a remarkable knowledge of medical history. The printing and set-up of this initial volume is quite first class.

**Cirugia estetica** By Dr RAMON PALACIO POSSE  
9½ × 6½ in Pp 299, with 187 illustrations 1945  
Buenos Aires El Ateneo Price not stated

THE title of this South American Spanish book seemed strange and sent the reviewer to the *Oxford English Dictionary* to see how the word "aesthetic" could be applied to surgery. We are familiar with the term "Prosthetic Surgery", which is defined as "that part of surgery which consists of supplying deficiencies, as by artificial limbs, teeth, etc., 1706". But "Æsthetic Surgery"? The Dictionary says that "aesthetic" means "of or pertaining to the appreciation of the beautiful", or, as an alternative meaning, "having or showing refined taste".

A survey of the book leads one to conclude that the term "Cirugia estetica" is meant to refer mainly to the surgical procedures required for the removal of blemishes and facial—mostly facial—deformities and irregularities, such as crooked noses, flapping ears, and wrinkles. Then there is also a long chapter on mammary hypertrophy and ptosis, with copious illustrations both before and after operation.

The whole work smacks of the beauty parlour rather than of academic surgery. Not that this type of work does not require the greatest skill. It does. And if anyone desires to do this type of work, this book should be of service.

**Tumores broncogenicos** La Cirurgia toracica en los Estado Unidos de Norte America By HERNAN D AGUILAR, Buenos Aires 8½ × 6½ in Pp 450 + x, with 12 illustrations and 7 plates 1946 Buenos Aires El Ateneo Price not stated

THIS book is based on the author's experiences in the study of bronchial tumours while spending two years in the United States, most of the time at the Barnes Hospital Chest Service, St Louis, under Professor Evarts A. Graham. It is, therefore, basically an account of the work at Barnes Hospital and includes a study of experiences in 264 cases of bronchial tumours and 52 consecutive pneumonectomies. It is well worth consulting by those especially interested in lung diseases and in the results of treatment in this world-famous centre of thoracic surgery.

## BOOK NOTICES

*[The Editorial Committee acknowledge with thanks the receipt of the following volumes. A selection will be made from these for review, precedence being given to new books and to those having the greatest interest to our readers.]*

**Röntgen Diagnosis of Diseases of the Gastro-intestinal Tract** By JOHN T. FARRELL, jun, M.D., Clinical Professor of Radiology, Graduate School of Medicine, University of Pennsylvania 9 × 6 in Pp 271 + x, with 190 illustrations 1946 Springfield, Ill. C. C. Thomas (London: Baillière, Tindal & Cox) 30s

**Anesthesia in General Practice** By STUART C. CULLEN, M.D., Head of Division of Anesthesiology, Department of Surgery, State University of Iowa Hospitals, Associate Professor of Surgery (Anesthesiology), State University of Iowa College of Medicine 8 × 5½ in Pp 260, with 36 illustrations 1946 Chicago The Year Book Publishers Inc (London: H. K. Lewis & Co) 21s

**The Principles of Anatomy** An Introduction to Human Biology By A. A. ABBIE, M.D., B.Sc., D.Sc. (Syd.), Ph.D. (Lond.), Elder Professor of Anatomy and Histology in the University of Adelaide. Second edition, revised and enlarged 8½ × 5½ in Pp 273 + x, with 76 illustrations 1946 Sydney and London Angus & Robertson Ltd 12s 6d net

**The Surgical Clinics of North America** Lahey Clinic Number Symposium on Colon Surgery 9 × 6 in Pp 274 + vii, with 82 illustrations London and Philadelphia W. B. Saunders Co Annual subscription (six numbers) papers 55s, cloth 75s

**Surgery of the Hand** By R. M. HANDFIELD-JONES, M.C., M.S., F.R.C.S., Surgeon to St Mary's Hospital, etc. Second edition 9½ × 6½ in Pp 164 + xii, with 104 illustrations 1946 Edinburgh E. & S. Livingstone Ltd 20s net

**Diagnosis and Management of the Thoracic Patient** The American Practitioner Series Edited by CHARLES PHILAMORE BAILEY, M.D. 9 × 6 in Pp 334 + ix, with numerous illustrations 1946 Philadelphia and London J. B. Lippincott Co 24s net

**The Surgery of Repair** Injuries and Burns By Wing-Commander D. N. MATTHEWS, O.B.E., R.A.F.V.R. Second edition 8½ × 5½ in Pp 401 + xii, with 198 illustrations, many in colour 1946 Oxford Blackwell Scientific Publications Ltd 45s net

### Surgical Treatment of the Motor-Skeletal System

By 43 authors. Supervising Editor FREDERIC W. BANCROFT, A.B., M.D., F.A.C.S., Associate Clinical Professor of Surgery, Columbia University, etc. Associate Editor CLAY RAY MURRAY, M.D., F.A.C.S., Professor of Orthopedic Surgery, College of Physicians and Surgeons, Columbia University, etc. In two volumes 10 × 6½ in Vol I Deformities, Paralytic Disorders, Muscles, Tendons, Bursae, New Growths, Bones, Joints, Amputations Pp 641 + xiv, with 521 illustrations Vol II Fractures, Dislocations, Sprains, Muscle and Tendon Injuries, Birth Injuries, Military Surgery Pp 671 + xix, with 543 illustrations 1946 Philadelphia and London J. B. Lippincott Co £6

**Amputation Prosthesis** Anatomic and Physiologic Considerations, with Principles of Alignment and Fitting designed for the Surgeon and Limb Manufacturer By ARTHUR THOMAS, M.D., F.A.C.S., Associate Professor of Surgery (Orthopedics), University of Colorado School of Medicine, and CHESTER C. HADDAR, President of the Association of Limb Manufacturers of America 9 × 6 in Pp 305 + xii, with 207 illustrations 1946 Philadelphia and London J. B. Lippincott Co 50s net

**Practical Points in Penicillin Treatment** By G. E. BEAUMONT, D.M. (Oxon.), F.R.C.P. (Lond.), Physician to the Middlesex Hospital, and K. N. V. PALMER, M.B. (Cantab.), M.R.C.P. (Lond.), Acting Medical Registrar to the Middlesex Hospital 7½ × 4½ in Pp 16 + iv, with 1 illustration 1946 London J. & A. Churchill 1s 6d net

**Thromboses arterielles** Physiologie pathologique et Traitement chirurgical By RENE LERICHE, Professeur au Collège de France, with the collaboration of D'IVAN BERTRAND, Directeur de l'Institut de Neurobiologie à la Salpêtrière 9 × 5½ in Pp 537 + viii, with 59 illustrations 1946 Paris Masson et Cie Fr 600

**Le Fibro-myome uterin** By J. DUCUING, Professor of Clinical Surgery at the Faculty of Medicine of Toulouse, Director of the Anti-cancer Centre 9½ × 6½ in Pp 541, with 156 illustrations 1946 Paris Masson et Cie Fr 735

# THE BRITISH JOURNAL OF SURGERY

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## DYSPLASIA EPIPHYSIALIS MULTIPLEX\*

BY SIR THOMAS FAIRBANK

CASES in which several epiphyses have shown irregular ossification have been published from time to time under a variety of titles. Some are undoubtedly examples of one or other of the recognized conditions in which changes in some of the epiphyses constitute a minor feature—these will be referred to later. Others have been described as cases of multiple osteochondritis, with little or nothing, in my opinion, to support this diagnosis. With pseudo-coxalgia, if this be taken as a typical example of osteochondritis, these cases show nothing in common except irregular ossification and flattening of the head of the femur as seen in a radiograph. The progressive changes characteristic of pseudo-coxalgia—increased density followed by irregular decalcification, progressing to fragmentation, and succeeded eventually by recalcification of the ossific nucleus—have not been recorded in the cases under discussion.

It is the purpose of this paper to describe the features of a condition which I believe should be regarded as a clinical entity. I suggest it is essentially a developmental error resulting from some unknown cause. It is characterized by dwarfism, stubby digits, and mottling or irregularity in density and outline of several of the developing epiphyses, and it lacks the other abnormalities of the skeleton necessary for its allocation to one of the well-recognized groups. Whenever one of these groups is studied, atypical cases are invariably met with and difficulty is experienced in deciding whether to include an individual case in the group or relegate it to the scrap-heap of unclassified cases. This is true of the condition under discussion.

The following description is founded on the study of 20 cases, 9 of which have already been published, but only 2 of them under the title of this paper. The radiographs of a further unquestionable case were shown to me recently by Mr N W Roberts. It is not claimed that the search of the literature has been exhaustive or that my decision to exclude a case has been invariably correct. Doubtful cases have been excluded.

The first case included was published by White in 1924 under the title of 'Chondro-dystrophia

Fœtalis (Achondroplasia)'. The radiographic picture of achondroplasia is now so well known that this diagnosis can be questioned without hesitation. In 1930 Buxton showed at the Royal Society of Medicine a 'dwarf with stippled epiphyses'. In 1934 Jansen published a case which he labelled 'epiphysial dysostosis'. All three of these cases I believe to be examples of the condition described below. In 1937 Gardiner-Hill, in his Oliver-Sharpey Lectures, referred to two sisters as suffering from 'hereditary deforming dyschondroplasia'. I ventured to disagree with him over this diagnosis and Dr Gardiner-Hill was good enough to furnish me with further details of these cases as well as of a boy he also referred to in the Lectures, but under a different title. All three of these cases, I believe should be placed in the group under discussion. Barrington-Ward, in 1912, published details of a brother and sister who had been under my care, and, although not included in this series, they are possible examples of this condition. In 1928 Grudzinski published two cases of atypical achondroplasia, or osteochondropathia multiplex, one of which at least appears to belong to the group under discussion. In 1943 Resnick published notes of a mother and her twin boys as cases of epiphysial dysplasia punctata. In my opinion, this diagnosis is unjustifiable, but I think they might well be placed in the multiplex group—they are not, however, included in my series. In 1935, in discussing the classification of generalized affections of the skeleton, I ventured to suggest 'epiphysial dysplasia' for the title of a group and briefly reported a case. To this title 'generalisata' was added, but this was altered later to 'multiplex', as being more accurate. In 1938 cases under this title were shown before the Royal Society of Medicine by Wiles and Yarrow respectively. There was some doubt at the time about the classification of the latter's case, but I think it should be included in the group.

The features of the condition found in the cases in this series are as follows. It is, of course, an affection of children and young people—the ages in this series varied from 6 to over 40 years. In one of Gardiner-Hill's cases the 'dyschondroplasia' was first noticed at the age of 18 months. One of my cases, first seen at 14 years, has been followed for over 20 years.

It affects both sexes (12 males, 8 females), and, as a rule, it is not familial. However, one case, a boy, has inherited it from

\* A much abridged version of this article, then founded on 15 cases, was communicated to the Orthopaedic Section of the Royal Society of Medicine in 1945. I am indebted to the Honorary Editors for permission to publish this enlarged and amended article elsewhere.

his mother, while two sisters are included in my series

Mr J A Cholmeley has furnished me with details of 2 cases, who are brothers and apparently the only ones affected in a family of ten. In another



FIG 297—Multiple epiphyseal dysplasia in a boy (D.A.) aged 9 years. Hips showing irregular mottling of femoral heads. (Under Dr K. M. Robertson)

case many members of the family were unduly short, but it was impossible to examine them.

Intelligence is usually normal in 2 cases, however, it was regarded as subnormal. Sexual infantilism was seen in only 1 case (Buxton's) the



FIG 298—Multiple epiphyseal dysplasia (P.R.) aged 7 years. Knees with some stippling of femoral heads. Left patella is dislocated. (Under Mr H. L.-C. Wood)

others being apparently normal in this respect. In 8 of the cases difficulty in walking was complained of, while in at least 5 others pain and stiffness of the knees or hips was the trouble which took them to hospital. In the older cases, as one would expect, arthritic symptoms are troublesome at times. Some degree of dwarfism, of the short limb type, is the

rule, it being definitely recorded in 16 of the cases. The facies typical of cretinism is absent. Some enlargement of the epiphyses is occasionally seen. The hands are striking, the fingers and thumbs being short, thick, and stubby with blunt ends, the relative length of the digits being normal. Apart from the dwarfism and the shape of the hands, there is no characteristic deformity, but the following were noted. Flexion deformity of the knees was found in 3 cases, with subluxation present in 1 (see below). In 1 case the elbows were flexed and laxity of the wrists and knees was present. In another a curious deformity of the elbows was seen, the radial heads being subluxated. In yet another there was limitation of abduction of the shoulders and of extension of the elbows, while the knees were flexed and the tibial heads subluxated backwards. Genu valgum was present in 4, dislocation of the patella in 1, and bow-legs in another. In Jansen's case both hips were flexed, the knees flexed and valgoid, and the feet in the varus position. The spine is usually normal in length and ossification. The one exception to this rule was Jansen's case, which showed marked platyspondyly, with flattening and gross irregularity in outline of the vertebral bodies. Kyphosis was present in one and lordosis in another. Nothing special has been noted in the teeth. Blood examinations have revealed nothing abnormal.

### RADIOLOGICAL FINDINGS

The essential abnormalities are seen in the epiphyses. The centres of ossification for the epiphyses may be late in appearing and backward



FIG 299—Ankles of same case as Fig 298, showing irregular ossification and wedge shape of lower tibial epiphysis, and some corresponding alteration in shape of astragalus.

in development, and fusion with the shafts may be delayed, but the principle change is irregularity in ossification. They are irregular both in density and shape, being mottled in appearance and perhaps mulberry-like in outline. Separate subsidiary centres around the main centre are common, and this results in some peripheral stippling, but this is never carried

to the point seen in the punctate type of epiphyseal dysplasia. There is a definite tendency towards improvement. As a rule, the epiphyses eventually

deformity are the hips (Figs 297, 302), shoulders, ankles, and less frequently the knees. The heads of the femora (and of the humeri) remain permanently



FIG 300—Multiple epiphyseal dysplasia in a girl (J. F.) aged 9 years. Shoulders showing striking irregularity in ossification of upper epiphysis of humerus. Considerable stippling is present. Shaft of humerus is abnormally stout (Under Mr J. A. Cholmeley)



FIG 301—Multiple epiphyseal dysplasia in a boy (J. H.) aged 7½ years. Wrists and hands showing backwardness of ossification of epiphyses of radius and ulna, and to some extent of the carpal bones, which are of irregular shape. Metacarpals and phalanges are shorter in comparison with their thickness than the normal.

become normal in density, but the outline, though usually smooth, remains permanently abnormal. Any or all of the epiphyses may be affected, but the most common to show typical changes and permanent



FIG 302—Multiple epiphyseal dysplasia in a boy (G. H.) aged 12 years. Hips showing retardation and irregularity of ossification of femoral heads and great trochanters (Under Dr H. Gardiner-Hill)



FIG 303—Knees of same case as Fig 302, showing curious angular shape of femoral condyles and gross irregularity of ossification of inner tuberosities of tibiae.

shallow and less convex than the normal. In one exceptional case, a girl of 8 years, the femoral heads had already assumed a smooth flattened shape, without irregular density. The same was true of the humeral heads (Figs 310, 311). In one typical case the femoral heads at the age of 27 still showed irregularity in outline and, on one side, partial fragmentation (Fig 315), a condition that might well

be mistaken for pseudo-coxalgia, which was, in fact, the diagnosis made when he was first seen at the age of 14. It is not surprising that in some of these cases this mistake should be made. The femoral neck may or may not be thickened. Some irregularity in shape of the acetabula was present in only 3 cases.

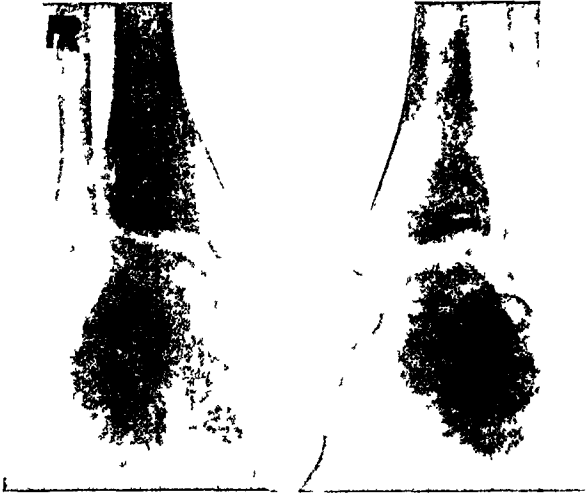


FIG 304—Ankles of same case as Fig 302, showing striking deformity of lower tibial epiphyses and corresponding alteration in shape of astragali.

The great trochanter may be affected. The femoral condyles may show little more in the way of abnormal ossification than is seen from time to time in perfectly normal children (Fig 298), the irregularity

shape is seen in some cases (Fig 303). The condyles in these cases are flattened and inclined to be



FIG 305—Wrist of same case as Fig 302, showing gross irregularity in shape and density of the lower epiphyses of the radius and ulna and abnormal shape of the carpal bones.



FIG 306—Multiple epiphyseal dysplasia in a girl (J. S.) aged 13 years. Anteroposterior and lateral views of knee showing exceptionally marked irregularity in ossification of femoral condyle and tibial head. Some posterior subluxation of tibia on femur. (Under Mr J. P. Campbell.)

in outline with separate points of ossification being particularly noticeable at the back of the condyles. In others the changes were much more marked (Fig 306). In older children when ossification of the condyles is well advanced striking alteration in

FIG 307—Shoulder of same case as Fig 306, showing gross irregularity in ossification of upper humeral epiphysis and abnormalities in the shape and density of the metaphysis.

rectangular. The patellæ may show decided mottling. In one case the fibula was elongated, the head being placed unduly high.

The ankles show changes of diagnostic value. A certain amount of obliquity of the joint is met with not infrequently in apparently normal individuals—it has been seen also in cretins—but in the condition

abnormally low. There was no corresponding inequality in length of the radius and ulna in this series with one exception—the radius is relatively long in Wiles's case.



FIG 308—Elbow of same case as Fig 306, showing delayed and abnormal ossification of epiphyses. Note the curious ossification of outer condyle; a dense nucleus for the capitellum being surrounded by less dense bone.

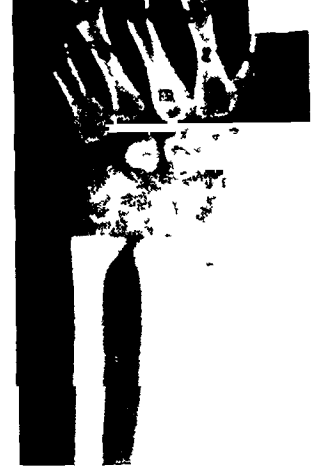


FIG 309—Wrist of same case as Fig 306, showing delay and irregularity in ossification of radial and ulnar epiphyses and of the carpal bones. The abnormal appearances are particularly striking in this case.

The upper epiphysis of the humerus usually shows obvious irregularity in ossification with fragmentation (Figs 300, 307) and sometimes the head appears to overlap the neck on the inner side to a striking degree (3 cases in this series). When ossification is advanced or complete the head remains flattened and less convex than usual (Fig 314). Occasionally the head may show even greater permanent distortion (Fig 317). The capitellum

under discussion the obliquity is marked. The lower tibial epiphyses diminish in depth from within outwards to an exceptional degree. The joint line is therefore oblique, and the trochlear portion of the



FIG 310—Multiple epiphysal dysplasia in a girl (J. P.) aged 8 years. Shoulders showing marked flattening of humeral head.



FIG 311—Hips of same case as Fig 310, showing shallow femoral heads, but without irregularity in density or fragmentation though child is only 8.

astragalus is misshapen to conform to this. This was a striking feature in at least ten of the cases (Figs 299, 304, 312). The astragalus may or may not be tilted outwards. In three of the cases, in addition to that mentioned above, the fibula was too long, but in these it was the lower end of the bone that was displaced, the external malleolus lying

and distal radial epiphysis show definite changes in some cases (Figs 301, 305, 309), but in the elbows and wrists no permanent deformity of importance has been noted with one exception, already referred to, in which there was subluxation outwards of the radial heads. In 3 cases the capitellum in each elbow shows in films a poorly calcified ossific centre,



irregular in outline and with a sharply defined nucleus of much greater density (*Fig 308*) The



FIG 312—Multiple epiphyseal dysplasia in a boy (D. B.) aged 6 years showing typical abnormal ossification of lower tibial epiphysis, with some distortion of astragalus. There is some trumpeting of the metaphyses of tibia and fibula (Under Mr R. Broomhead)



FIG 314—Multiple epiphyseal dysplasia in a man (A. M. R.) aged 26 after being under observation for 12 years. Note flattening of humeral head and abnormal shape of glenoid. The other shoulder showed similar abnormalities

metaphyses show no consistent or characteristic change. In a few cases they were trumpeted, and the epiphysal lines irregular. In one some cystic-like change in the metaphyses was noted. The occasional overlap of the metaphysis by the humeral head on the inner side has already been referred to. In 1 case the epiphysis for the tibial head lay in an



FIG 313—Foot and ankle of same case as *Fig 311*, showing irregular shape of tarsal bones

oblique anteroposterior plane and the tibia was subluxated backwards on the femur (*Fig 306*)

The shafts of the long bones are often shorter than normal, but not thickened as a rule (*Fig 300*). Only in 1 case were they unduly curved. The carpal and tarsal bones ossify late, and may be very irregular in outline (*Figs 301, 305, 309, 313*). The metacarpals, metatarsals, and phalanges are stunted (*Figs 301, 316*). The epiphyses of some of these bones may show irregular ossification. In a few the metacarpals are rather suggestive of the Morquio-Brailsford type of osteochondro-dystrophy. The vertebral bodies show no peculiarities, the spine being normal, as a rule, only in 1 case already referred to were the vertebral bodies shallow and spread. The skull and teeth show no abnormalities



FIG 315—Hips of same case as *Fig 314*. Note irregular shape of both femoral heads with partial fragmentation still present in the left. Arthritic symptoms in left hip were complained of at times

The pathology is obscure In Jansen's case a portion of the metaphysis, unfortunately not the epiphysis, at the lower end of a femur was examined microscopically If I may venture an opinion on the published microphotograph I would say it shows mucoid degeneration

signs of this are absent, and there is no improvement in the appearance of the epiphyses in response to appropriate treatment Two of the cases in our series were treated vigorously with thyroid, one for as long as two years, without obvious benefit In cretins also the fingers are thick and stubby, but they fail to show their usual differences in length Delay in fusion at the epiphysial line in cretins is associated with sclerosis of the terminal layer of the metaphysis It is of interest to note that flattening of the humeral heads, strikingly similar to that seen in epiphysial dysplasia, has been seen in a cretin of 39 (Berard and Novel, 1930)

In dysplasia epiphysialis punctata, as it is now called, or stippled epiphyses, the *whole* of an epiphysis seems to be ossifying from a large number of discrete centres The shafts of the long bones are short and thick, and the ends may be enlarged and splayed The tarsal bones may be completely stippled, showing nothing but a collection of dots The abnormalities generally are much more gross than in most cases of the multiplex group, and no difficulty should be experienced in differentiating the two Congenital cataract occurs in about half the cases

In chondro-osteo-dystrophy of the Morquio-Brailsford type, but not in gargoylism as a rule, the femoral heads show striking epiphysial changes, but in this condition the acetabula are markedly enlarged and irregular Other epiphyses and the carpal and tarsal bones frequently show irregularity in ossification, but notable features are the abrupt kyphotic deformity in the dorsolumbar region, resulting from the diminution in size of one vertebral body, which is displaced backwards, and the shape of the vertebral bodies, in the latter the central prolongation anteriorly is quite distinctive and diagnostic

In dyschondroplasia changes in the epiphyses, when seen, are of no importance, being completely



FIG 316—Hand of same case as Fig 314, showing typical blunt broad digits

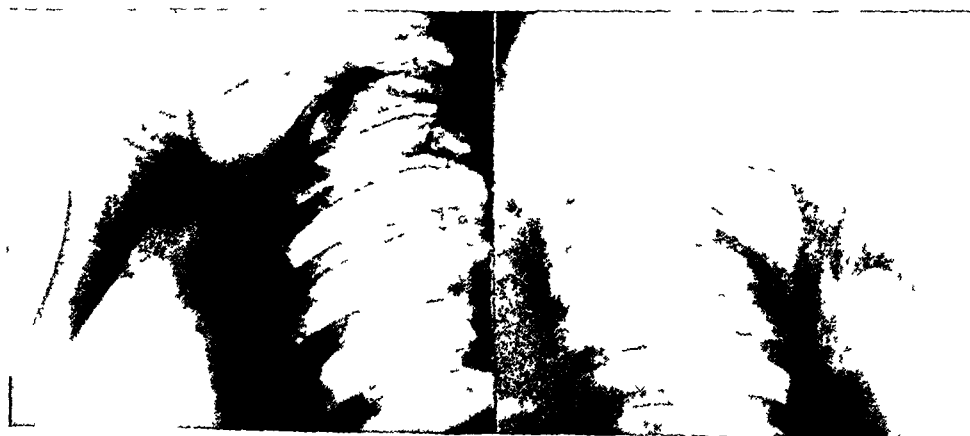


FIG 317—Shoulders of a middle-aged woman, showing unusually marked changes in shape of the humeral heads and glenoid cavities The changes seen in other joints strongly suggest this case is one of multiple epiphysial dysplasia (By courtesy of Dr H Austin Williams)

## DIFFERENTIAL DIAGNOSIS

There are at least seven other conditions, besides osteochondritis, in which the epiphyses may show irregular ossification Obviously cretinism is the first general condition to be excluded The classical

overshadowed by the gross abnormality of the metaphyses, irregularity in density of an epiphysis is never seen except when the adjacent portion of the metaphysis contains obvious masses of cartilage Dyschondroplasia is usually, but not invariably, unilateral in distribution The affected portions of

the bones, i.e., the chondromatous areas, become stippled with dense spots in the later or recovering stages of the condition. In that skeletal curiosity called osteopoikilosis, the epiphyses are of normal shape, and, whether fused to the shaft or not, show large numbers of the characteristic discrete dense spots, though these are by no means confined to the epiphyses. In osteopetrosis or marble bones, some of the epiphyses may show irregular density or stippling, but the changes in the shafts dominate the picture.

Lastly, mottled epiphyses have been described in association with pituitary gigantism (Traub, 1939). Some mottling, particularly of the femoral heads, has been met with very occasionally in other endocrine errors and in cases which at present it is impossible to classify.

Finally, I would suggest that if there is reason to suspect pseudo-coxalgia in a patient below the average in height, it is well worth while having films taken of the shoulders and ankles to exclude the developmental error which is the subject of this paper.

I am greatly indebted to the following friends who have supplied me with details of cases under their care: Mr R Broomhead, Dr G T Calthrop, Mr J P Campbell, Mr J A Cholmeley, Dr E A Cockayne, Dr H Gardiner-Hill, Mr A D Le Vay, Dr K M Robertson, Mr V C Snell, Dr H Austin Williams, and Mr H L-C Wood.

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## SARCOMA IN ABNORMAL BONES

By HARRY PLATT

PROFESSOR OF ORTHOPÆDIC SURGERY UNIVERSITY OF MANCHESTER

In a personal series of 180 fully documented primary malignant tumours of bone (period 1920-45), of 161 tumours belonging to the sarcoma group, 18 are sarcomas occurring in abnormal bones. This sub-group, which comprises (1) 10 sarcomas occurring in Paget's disease, (2) 2 sarcomas arising in fibrocystic disease, and (3) 6 tumours representing the malignant transformation of a previously benign osteochondroma, presents a number of instructive features which illustrate the wide variations in the behaviour pattern of bone sarcoma.

### 1 PAGET SARCOMA

The incidence of sarcoma in osteodystrophia deformans has been estimated by various observers as between 5 and 10 per cent. Paget himself was aware of the liability of the victims of the disease which later was to bear his name to develop malignant tumours, but of the 5 cases he reported, in only 2 did the tumour arise definitely in connexion with bone (1889).

Of my own cases, 8 were males and 2 females. The malignant tumours appeared in 4 patients between the ages of 50 and 60, and in 6 patients over 60. Of the bones affected 4 tumours involved the femur (lower end, 3, upper end, 1), 4 the humerus (upper end, 2—in the same patient, and shaft, 2), and 3 were pelvic tumours (ilium, 2, pubis, 1). In the majority of the cases there was a fairly long prodromal stage in which Paget's disease had manifested either in one bone or throughout a considerable part of the skeleton before the appearance of the tumour. The histological type of tumour in all cases was a spindle or polymorphic sarcoma.

Two additional cases have recently come under my care (1946)—both females—one a sarcoma of the upper end of the humerus arising in a somewhat atypical form of Paget's disease with predominantly

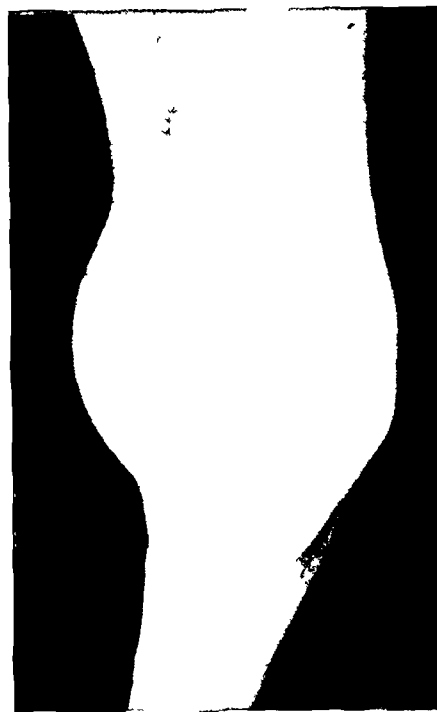


FIG 318—Case 1. M, aged 63. Paget's disease. Large sarcoma of lower end of femur.

osteoporotic changes in the affected bones (Figs 332, 333), the second case, a woman of over 70 with generalized Paget's disease of long standing, with multiple tumours in the frontal and parietal areas of the skull

In my experience these Paget sarcomas have proved to be highly lethal. Seven patients died within the year following the discovery of the tumour

**Comment**—Long prodromal period. Irregular distribution of Paget's disease in skeleton. Short survival after amputation

**Case 2**—Female, aged 60. Sarcoma of lower end of femur (L.)

**HISTORY**—Seven years ago sustained subtrochanteric fracture of left femur. Three months ago left knee became swollen

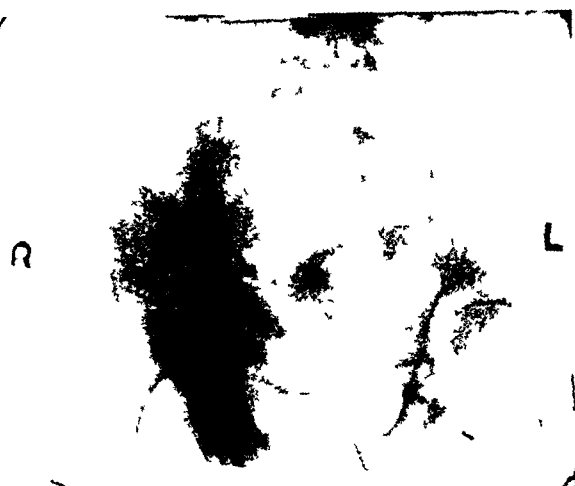


FIG 319—Same case. Gross changes in right half of pelvis and lumbar spine

and its treatment. But 1 patient is still alive (1946) two years after disarticulation at the shoulder for a sarcoma of the upper end of the humerus (Case 5)

Seven patients were treated by radical operations: 3 by disarticulation at the shoulder-joint, 2 by amputation through the thigh, 1 by disarticulation at the hip, and 1 by a *hindquarter amputation*—the last being one of a series of 6 patients in whom I have carried out this formidable procedure during the past eight years for the treatment of malignant tumours of the bony pelvis. In the inaccessible tumours irradiation was used with no appreciable effect on the tumour or benefit to the patient in general

### ILLUSTRATIVE CASES

**Case 1**—Male, aged 63. Sarcoma of lower end of femur (L.)

**HISTORY**—Pain in left knee with increasing stiffness—five years' duration. Three weeks before entering hospital knee became much more swollen after a fall. Loss of weight during last few months

**ON EXAMINATION** (Aug 16, 1938)—Looks thin and worn. Left knee almost fixed in 90° flexion with large mass incorporated with lower end of femur extending round to popliteal region (Fig 318). Spine rounded do—

—Gross changes of Paget's disease in pelvis (R half only), lumbar spine. Skull normal. Left femur (lower half) Paget's changes with destruction of lower third of shaft and soft-tissue shadow filling popliteal fossa (Figs 319, 320)

**TREATMENT**—Amputation of upper third of thigh on Aug 26

**AFTER-TREATMENT**—Coley's toxins for three weeks. X-ray therapy

**HISTOLOGY**—Spindle-cell sarcoma (Fig 321)

**RESULT**—Death 3½ months after amputation



FIG 320—Same case. Showing destructive changes and soft-tissue shadow

**ON EXAMINATION** (Aug 31, 1937)—L knee enormous swelling and enlargement of lower end of femur with dilated veins in overlying skin (Fig 322)

**X-ray Examination**—Changes of Paget's disease in skull, left femur, and pelvis, localized destruction of

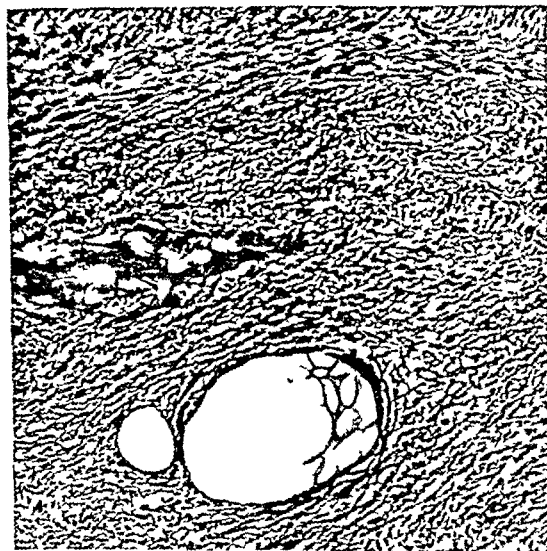


FIG 321—Same case. Microphotograph showing spindle-cell sarcoma ( $\times 40$ )

lower end of femur and shadow of large extra-osseous tumour (Figs 323, 324)

**TREATMENT**—Disarticulation of left hip on Jan 10, 1938

**HISTOLOGY**—Spindle-cell sarcoma

**RESULT**—Patient died six days later with signs of renal failure

**Comment**—Long-standing Paget's disease. Massive sarcoma involving lower end of left femur with



FIG 322—Case 2 F, aged 60 Paget's disease Sarcoma lower end of femur Large tumour Note discoloration and dilated veins



FIG 323—Same case Shows Paget's disease of pelvis and left femur



FIG 324—Same case Shows massive destruction



FIG 325—Same case Amputation specimen showing two tumour masses (1) lower end of femur and (2) upper end of femur—representing spread along fascial planes

# SARCOMA IN ABNORMAL BONES

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spread upwards along fascial planes to the region of the great trochanter, where there was another large mass. Tumour *not* apparently of multicentric origin (Fig 325)



FIG 326—Case 3 M, aged 53. Paget's disease. Sarcoma of pelvis. Shows Paget's changes in pelvis and femur, with destruction in pubic ramus and soft tissue shadow

**Case 3—Male, aged 53 Sarcoma of pelvis (L)**  
**HISTORY**—Pain for six weeks, gnawing in character, on lateral aspect of left knee, worse at night. Recently noted painful lump in left groin.

**ON EXAMINATION** (Oct 4, 1939)—L thigh large irregular mass in Scarpa's triangle firmly attached to pubis and pubic ramus. Hip movements slight limitation of flexion and abduction.  
**X-ray Examination**—(1) Paget's changes in pelvis, lower spine, and left femur—dense osteosclerosis (2) Area of destruction in left pubic ramus, with soft-tissue shadow—pathological fracture through ramus (Fig 326)

**TREATMENT**—Hindquarter amputation, left, Oct 13 (Fig 327)  
**SUBSEQUENT COURSE**—Three months later mass observed in left erector spinæ  
**X-ray Examination**—Pelvis extensive destruction of sacrum. Spine deposit in 3rd lumbar vertebra. Chest secondary deposits.

**RESULT**—Death three and a half months after hindquarter amputation.  
**Comment**—Pre-existing Paget's disease of long duration. Short survival following hindquarter amputation.

**Case 4—Male, aged 61 Sarcoma of upper end of humerus (R and L)**

**HISTORY**—Sept 16, 1938 Attended fracture clinic after fall on to right shoulder. Radiograph showed crack across surgical neck of humerus with appearances suggesting Paget's disease. Recovery of almost full range of movements in shoulder.  
 Dec 4, 1939 Admitted to hospital with swelling upper end of right humerus.  
**ON EXAMINATION**—Swelling right shoulder and upper third arm, limitation of movement at shoulder-joint.  
**X-ray Examination**—Humerus (R) Areas of dense bone with mottling, new bone, outer side of head and

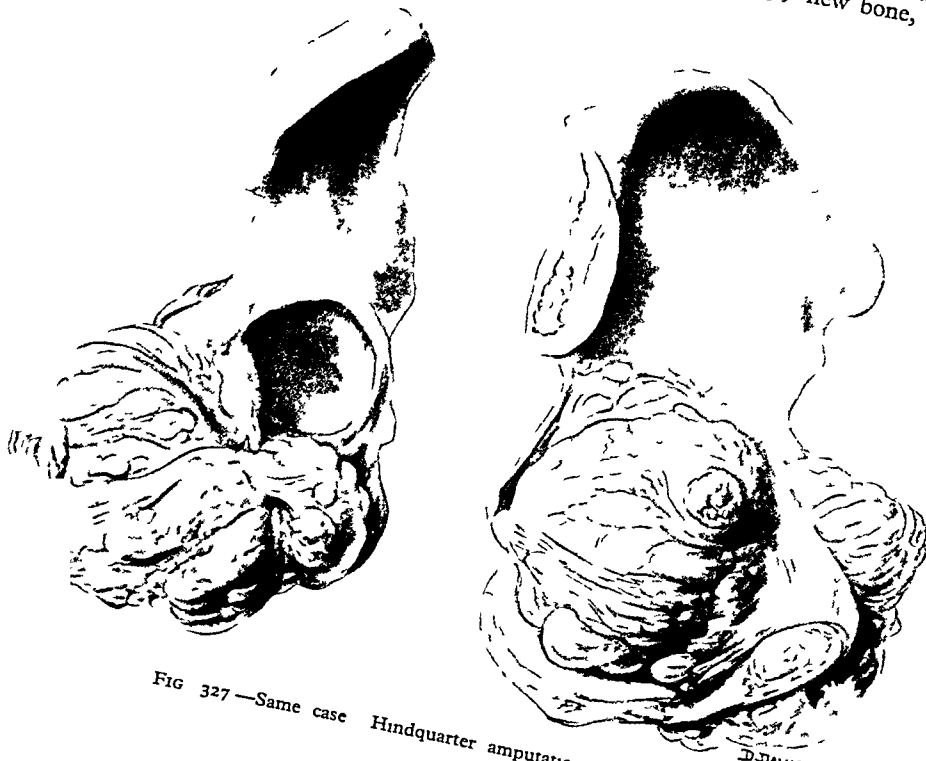


FIG 327—Same case Hindquarter amputation specimen

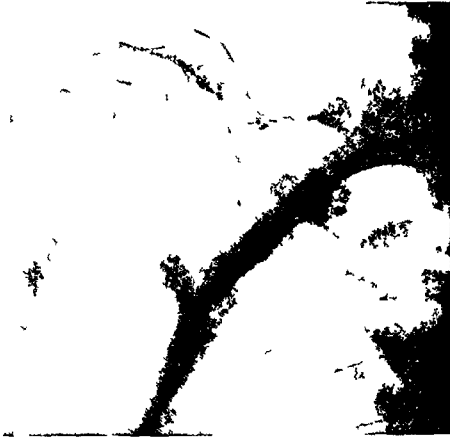
D. DAVISON

neck of humerus (*Fig 328*) Lumbar spine and pelvis no changes

*Biopsy*—Dec 20, 1939

*TREATMENT*—Disarticulation of shoulder (R)

*HISTOLOGY*—Spindle-cell sarcoma



*FIG 328*—Case 4 M, aged 61 Paget's disease Sarcoma of upper end of humerus (R and L) Tumour of upper end of humerus (R)

#### PROGRESS—

Jan 11, 1940 Local recurrence in amputation scar in right axilla Put on deep X-ray therapy Mass remained stationary in size

Nov 26 Tumour mass now discovered in left shoulder region, mass in right axilla not increased in size Radiography massive destruction of upper end of left humerus and scapula (*Fig 329*)

*RESULT*—Death (Jan 26, 1941)

*Comment*—Paget's disease of some years' standing Two separate tumours arising in the upper end of each humerus Short survival following disarticulation of the upper limb for the sarcoma first discovered An example of multicentric tumour formation

*Case 5*—Male, aged 67 Sarcoma of shaft of humerus (R)

#### *HISTORY*—

June 19, 1942 While digging in the garden, fell and right arm "gave way"—fracture humerus diagnosed—changes of Paget's disease not recognized at that time Fracture united in three months

May, 1944 Returned complaining of pain and swelling in right arm of three days' duration

*ON EXAMINATION*—R arm mass in upper third involving humerus

*X-ray Examination*—Paget's changes with localized destruction (*Fig 330*)

*TREATMENT*—Disarticulation at shoulder (June 19, 1944) (*Fig 331*)

*HISTOLOGY*—Polymorphic-cell sarcoma

*SUBSEQUENT COURSE*—Well, no signs of local recurrence or secondaries elsewhere two years later (June, 1946)

*Comment*—Long prodromal stage before development of tumour Survival two years following amputation

*Case 6*—Female, aged 62 Sarcoma of humerus (L)

#### *HISTORY AND SIGNS*—

1944 Extensive changes in upper third of humerus (L) with restriction of movement at shoulder discovered after two years of pain Radiographic changes compatible with Paget's disease, but porotic changes predominant

Throughout 1945 severe pain which defied all forms of drug therapy

December, 1945 Radiography showed destructive changes in head of humerus suggesting malignant change (*Fig 332*)



*FIG 329*—Same case Second tumour in the same patient upper end of left humerus

*TREATMENT*—Irradiation with no relief followed by discovery of spontaneous fracture with gross destructive changes, but no palpable extra-osseous tumour

R



*FIG 330*—Case 5 M, aged 67 Paget's disease Sarcoma of shaft of humerus Extensive Paget's disease in humerus with tumour in middle of shaft

March 11, 1946 Disarticulation at shoulder (*Fig 333*)



FIG 331—Same case as Fig 330 Amputation specimen



FIG 332—Same case as in Fig 333 Amputation specimen Note predominantly osteoporotic change



**HISTOLOGY**—Spindle-cell sarcoma  
**Comment**—Case presents two unusual and striking features (1) A predominantly osteoporotic type of Paget's disease, (2) A true endosteal or central sarcoma with no evidence of extra-osseous tumour

## 2 SARCOMA IN FIBROCYSTIC DISEASE

Sarcomatous transformation in a benign cyst or focal area of osteodystrophia fibrosa would appear to be a very rare phenomenon (Coley and Stewart, 1945) The 2 examples in the present series were sarcomas arising in dystrophic cysts after comparatively long intervals The first case was the malignant transformation of a large cyst of the ilium in a

FIG 332—Case 6 F, aged 62 Paget's disease Sarcoma of upper end of humerus (L) Extensive Paget's changes in humerus with expansile lesion occupying head and neck of the bone



young man under observation for seven years in whom, after death, a large sarcoma was found completely filling the pelvis, but with no trace of secondary deposits elsewhere (Figs 334-337). The second

case was a man with a dystrophic cyst in the upper end of the humerus which, ten years later, at the age of 48, began to behave as a tumour and was found at biopsy to be a fibrosarcoma. The limb



FIG 334—M, aged 18. Fibrocystic disease of pelvis. Shows large cyst in ilium after curettage and insertion of bone graft. Histological examination of cyst contents showed changes of fibrocystic disease only.

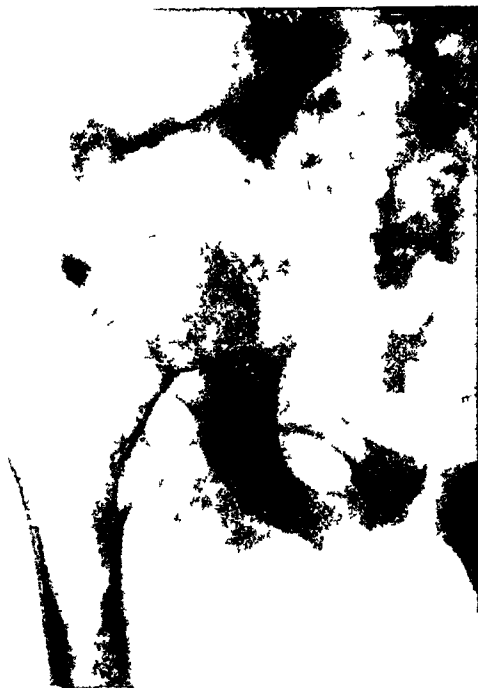


FIG 335—Same case. Condition eleven months later. Shows extension of cyst and displacement of head of femur.



FIG 336—Same case. Condition four years later. Almost complete destruction of bony pelvis on right side, with further displacement of femur. Extension of lesion into sacrum on right side. Biopsy at this stage revealed sarcomatous change.

was disarticulated at the shoulder, and the patient is known to be alive at the present time, nine years after the operation. A subsequent histological study of material from the amputation specimen has confirmed the original diagnosis.

The experience of these two rare cases reinforces one's belief in the wisdom of obliterating dystrophic cysts in adults by appropriate operative procedures (curettage and the implantation of bone-grafts).

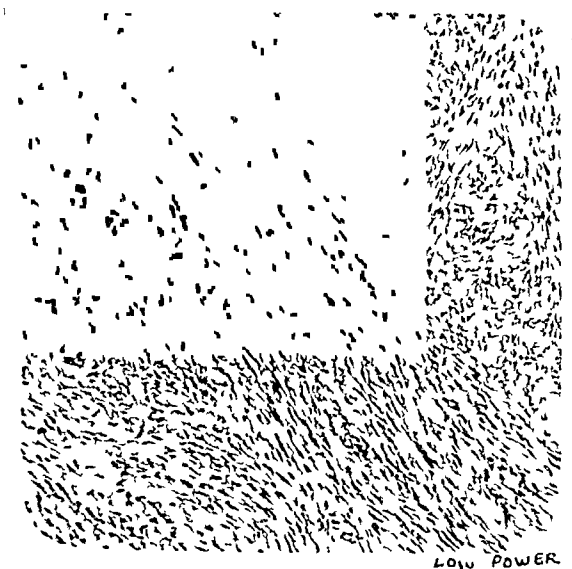


FIG 337—Same case. Microphotograph showing spindle cell sarcoma.

### 3 MALIGNANT TRANSFORMATION IN BENIGN OSTEOCHONDROMA

The 6 examples of malignancy supervening in benign osteochondroma represent a type of tumour whose characteristics are fairly well known. Three of these tumours appear in my recorded series of 23 five-year survivals in various types of bone sarcoma (Platt, 1947). The recognition of the advent of malignancy in a chondroma or osteochondroma is not always an easy matter, and more especially in tumours with a long history which later grow to an enormous size, and which may be relatively inaccessible, as for example when involving the bony pelvis (Fig 338). Paget pointed out long



FIG 338—M, aged 24. Osteochondroma of pelvis. Enormous osteochondroma. No histological proof of malignant change.

ago (1853) that rapid growth and large size are not in themselves criteria of malignancy, and the truth of this observation is borne out in the recent study of osteochondromata of the pelvic bones by Ghormley, Meyerding, Mussey, and Luckey (1946). Nevertheless, a presumed benign osteochondroma which begins to increase in size should be effectively removed before it reaches the dangerous stage of transition into malignancy.

### SUMMARY

1 A study of 18 sarcomas arising in abnormal bones is presented.

2 The prognosis in the sarcomas of Paget's disease would appear to be grave. In 7 out of 10 cases in the series the patients died within a year from the discovery of the tumour and its treatment. One patient only, a man of 67 with a sarcoma of the humerus, has so far survived two years from the time of amputation.

3 The appearance of sarcoma in an area of fibrocystic disease is a rare phenomenon. In the 2 recorded cases the survival periods were two years and nine years respectively. In the former, an inoperable tumour of the pelvis of gigantic size, at the time of death no evidence of metastasis was revealed.

4 In the type of sarcoma resulting from the malignant transformation of an osteochondroma (6 cases in the series), examples of long survival periods are likely to be encountered. Although rapid growth and the attainment of enormous size are not in themselves conclusive evidence of the advent of malignant change, tumours which behave in this fashion should be eradicated without delay.

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# NEEDLE BIOPSY IN THE CLINICAL DIAGNOSIS OF TUMOURS

By FRANK ELLIS

## DIAGNOSIS BY NEEDLE BIOPSY

WITHOUT histological evidence the true nature of a neoplasm may be unknown and the critical attitude to published series of results of treatment, especially by radiotherapy, without this evidence is such that it must be considered essential. Clinical findings with radiological and laboratory evidence unsupported by histology may often be misleading and doubt of the diagnosis becomes especially marked when five-year cures by radiotherapy are used to assess the value of treatment.

Khanolkar and Sharpure (1944) show in a review that in various surgical clinics clinical diagnosis was wrong in from 10 to 57 per cent of cases as compared

Needle biopsy causes less disturbance and therefore, on *a priori* grounds, less danger than other methods for non-ulcerated lesions. Coley et al (1931) found no untoward effects in bone tumours, and Martin and Stewart (1936) report in similar manner on 3500 cases of aspiration biopsy, including many cases of visceral puncture and 60 cases of cervical lymph-node metastasis free of disease from 1 to 6 years following treatment by radiation.

Aspiration biopsy as an aid to rapid diagnosis of malignant neoplasms has been developed principally by Martin and Ellis (1930), since when its use and results have been reported by them (1934, 1940) and by many other workers (Ferguson, 1930, Coley, Sharp, and Ellis, 1931, Stewart, 1933, Binkley,

Table I—ASPIRATION BIOPSIES CHRONOLOGICAL ANALYSIS

	MALIGNANT CORRECT	MALIGNANT INCORRECT	NON-MALIGNANT CORRECT	NON-MALIGNANT INCORRECT	NO RESULT —LATER MALIGNANT	NO RESULT —FATE UNKNOWN	DIAGNOSIS UNKNOWN	NO RESULT —LATER NON-MALIGNANT	TOTAL	PER-CENTAGE OF USEFUL BIOPSIES
1936	7 (50 per cent)	0	4 (29 per cent)	0	2	1	0	0	14	79
1937	21 (47 per cent)	2	3 (7 per cent)	0	10	8	0	1	45	54
1938	57 (65 per cent)	4	7 (8 per cent)	3	4	9	0	3	87	73
1939	59 (59 per cent)	0	9 (9 per cent)	0	8	13	7	4	100	68
1940	46 (52 per cent)	0	9 (10 per cent)	1	5	19	2	6	88	62
1941	70 (51 per cent)	2	15 (11 per cent)	4	20	17	3	6	137	62
1942	98 (50 per cent)	0	14 (7 per cent)	3	34	42	4	0	195	57
1943	10 (43 per cent)	0	4 (17 per cent)	0	3	5	1	0	23	60
	368 (54 per cent)	8 (1.2 per cent)	65 (9 per cent)	11 (1.6 per cent)	86 (13 per cent)	114 (15 per cent)	17 (2.5 per cent)	20 (3 per cent)	689	63

Table II—ASPIRATION BIOPSIES ANALYSIS OF RESULTS FOR CERTAIN SITES

	MALIGNANT CORRECT	MALIGNANT INCORRECT	NON-MALIGNANT CORRECT	NON-MALIGNANT INCORRECT	NO RESULT —LATER MALIGNANT	NO RESULT —FATE UNKNOWN	DIAGNOSIS UNKNOWN	NO RESULT —LATER NON-MALIGNANT	TOTAL	PER-CENTAGE OF USEFUL BIOPSIES
Glands	151	3	26	10	32	44	9	5	280	63
Bone	48	1	4	0	12	12	7	3	87	60
Breast	49	1	14	3	15	19	3	4	108	58
Intrathoracic	10	0	0	0	3	4	0	1	18	56
Abdominal	13	0	1	0	6	2	0	0	22	64
Prostate	5	0	0	0	0	5	0	0	10	50
Kidney	2	0	0	0	0	0	0	0	2	100
Totals	278	5	45	13	68	86	19	13	527	61.3

with the subsequent histological diagnosis. Biopsy from an ulcerated surface has no serious dangers, as shown by various authors. Marzloff (1923) showed that 36.8 per cent of 38 long-surviving cases of cancer of the cervix uteri had a diagnostic curettage several days before operation. Haagensen and Stout (1942) found 49 per cent five-year cures with biopsy as against 34 per cent without. Paterson and Nuttall (1939) reported similar findings in accessible carcinoma of the tongue and lip.

1939, Sayago, 1942, Iversen and Roholm, 1939, Ottolenghi, 1943).

**Indications for Needle Biopsy**—These are—

- 1 When a tumour lies deep to normal skin or other tissues
- 2 When the possibility exists of the tumour being infected
- 3 When a major operation would otherwise be necessary and when such an operation would not allow of the successful extirpation of the tumour

# NEEDLE BIOPSY IN DIAGNOSIS OF TUMOURS

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4 When usual methods of obtaining histological evidence are contra-indicated

5 When excision of a lymph-node is contemplated in a suspected case of Hodgkin's disease, needle biopsy may exclude cancer and may establish a diagnosis of Hodgkin's disease

The experience which I have had with aspiration biopsies has been sufficiently encouraging to justify its frequent use. Many of the unproductive biopsies were attempted on lesions of doubtful nature and even with a doubt in some cases of the existence of a pathological process. The final tables were prepared by comparing the result of the aspiration biopsy with the clinical notes based on an efficient follow-up system

## RESULTS

**Aspiration Biopsy**—Table I shows the chronological distribution of the aspiration biopsies carried out by the author at the Sheffield Royal Infirmary and Royal Hospital, Sheffield, with an indication of the percentage distribution of the useful biopsies (i.e., malignant correct plus non-malignant correct). The figures for the years 1936 and 1943 do not cover the whole year in either case because the method was first adopted in 1936 and because I left Sheffield at the end of April, 1943

It would appear that the greater the number of aspiration biopsies taken in any one year, the greater tends to be the 'wastage', since in 1941 and 1942 the percentages of useful results, corresponding to 137 and 195 biopsies respectively, were 62 per cent and 57 per cent. The reason for this may be the greater confidence developed in attempting biopsies on many kinds of unpromising lesions, although at all times the decision to carry out the examination is made because of the necessity for determining the histology of a lesion and the difficulties of varying kinds in making such determination by a more drastic surgical approach

Table II shows an analysis of biopsies from several sites indicating the number of definite diagnoses and the percentages of useful diagnoses for these sites. In the case of lymphatic glands the biopsies were mostly taken from the neck, as shown by Table III

Table III—ASPIRATION BIOPSIES  
Regional Lymph-glands from which  
Biopsies Taken

Region	No	Taken
Axillary	16	
Neck	176	
Supraclavicular	26	
Submaxillary	16	
Groin	28	
Iliac	3	
Submental	1	
Unknown or other regions	14	
Total	280	

In the case of lesions of bone the biopsies were mostly taken from the femur and the mandible, as shown in Table IV

The distribution of the correct malignant diagnoses, according to the histology and the site from which the biopsy was taken is listed in Table V. No attempt is made in this table to distinguish between primary and metastatic lesions

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Table IV—ASPIRATION BIOPSIES  
Bones from which Biopsies Taken

Name of Bone	No	Taken	Name of Bone	No	Taken
Bone			Mandible	11	
Humerus	5		Maxilla	6	
Lumbar	6		Skull	4	
vertebrae	5		Scapula	4	
Femur	21		Rib	1	
Sternum	7		Pubis	3	
Ilium	7		Clavicle	2	
Sacrum	4		Ischium	1	
Total	87				

Table V—ASPIRATION BIOPSIES  
DIAGNOSIS CORRELATED WITH SITE OF BIOPSY IN CASES  
DIAGNOSED AS MALIGNANT (368 CASES)

ADENOCARCINOMA (101)		PROSTATE	
Bone	1	Bone	3
Humerus	1	Kidney	3
Thyroid	1	Chest wall	2
Sternum	3	Ilium	1
Abdomen	4	Pelvis	1
Intrathoracic	2	Skull	1
Muscle	5		
Site unknown	2		
SARCOMA (33)		Gland	
Bone	3	Pubis	3
Maxilla	1	Retroperitoneal	1
Ilium	1	Tibia	1
Mandible	3		
THYROID CARCINOMA (2)		MIXED SALIVARY TUMOUR (7)	
Skull	1	Parotid	4
CARCINOMA OF UNKNOWN TYPE (41)		OSTEOSARCOMA (1)	
Muscle	2		
Pelvis	2		
Gland	1		
Liver	21		
Orbit	1		
BASAL-CELL CARCINOMA (6)		SQUAMOUS CARCINOMA (85)	
Temple	1	Maxilla	2
Parotid	1	Site unknown	3
MELANOCARCINOMA (2)		Vertebra	2
Muscle	1	Forehead	1
Gland	1	Thyroid	1
HODGKIN'S DISEASE (4)			
Chest wall	2		
Penis	1		
Abdomen	1		
Sacrum	1		
TRANSITIONAL-CELL EPITHELIOMA (21)		RETICULUM-CELL SARCOMA (11)	
Thyroid	1	Pelvis	1
Chest wall	1	Orbit	1
CARCINOMA OF LUNG (22)		LYMPHOSARCOMA (1)	
Chest wall	1		
CHONDROSARCOMA (2)		PLASMA-CELL MYELOMA (2)	
Sternum	1		
TYPE UNKNOWN (22)		FIBROSARCOMA (1)	
Alveolus	7		
Breast	1		
Muscle	1		
Abdomen	1		
Ischium	2		
MYELOBLASTIC MYELOMA (1)		HYPERNEPHROMA (1)	
MEDULLOBLASTOMA (1)		SEMINOMA (1)	

Aspiration biopsy, as can be seen from *Table I*, gave on the average about 63 per cent of useful results

**Drill Biopsy**—In 1944, having encountered a note by Christiansen in *Acta radiologica* of the possibility of drilling out a piece of tissue by means of a squared-off needle bevelled to have a cutting

biopsy It is seen that the results of drill biopsy were consistently better than those of aspiration biopsy This advantage is most marked in the case of biopsies taken from the breast

These figures, moreover, do not represent all the advantages of drill biopsy because the pathologists' reports have been consistently more

*Table VI*—DRILL BIOPSIES\*

	NORMAL	DOUBTFUL	USELESS	BENIGN	MALIGNANT	TOTAL	PERCENTAGE OF USEFUL BIOPSIES
Bone	1	4	7	16	9	37	68
Glands	4	21	9	5	57	96	65
Liver	0	1	0	0	1	2	—
Thyroid	0	3	1	2	1	7	40
Intra abdominal	0	2	0	1	7	10	80
Breast	1	1	0	1	18	21	90
Antrum	0	1	0	0	3	4	—
Other soft tissues	1	8	2	12	18	41	73
Totals	7	41	19	37	114	218	69

\* This table does not include cases of carcinoma of prostate

edge, I decided to try such a needle at the London Hospital with a dental drilling machine to provide the rotating power The biopsies are referred to as 'drill biopsies'

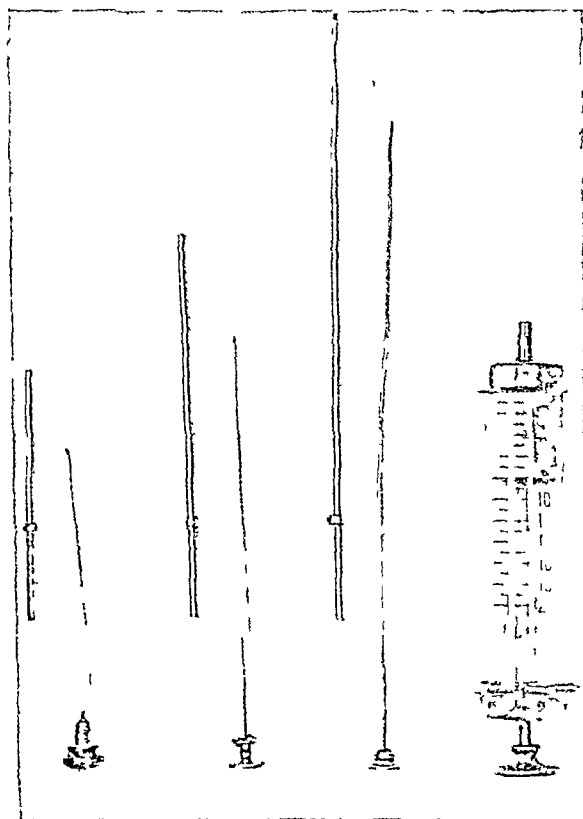


FIG 339—Squared-off bevelled needle for drill biopsy

A survey of the results between October, 1944, and the end of February, 1946, is provided in *Table VI* This should be compared with *Table II* giving a comparable survey of the results of aspiration

biopsy confident than those from the same pathologist of aspiration biopsy and the technique has been improved only recently, so that results are still better At first, the needles used were ordinary needles with a bayonet fitting (for attachment to the syringe) which attached the needle securely during the drilling to an adaptor fitted into the driving mechanism of the drilling machine Attached in this way it was difficult to get all the needles to rotate accurately on their axes Therefore, needles, as shown in *Fig 339*, were made in the workshops of the London Hospital They have a similar sharpened end, but the attachment to the drilling machine obviates the use of an adaptor and the needles rotate more truly and better specimens are obtained This improvement came into use during the last week in January, 1946

As complete a list as possible of the results of the drill biopsies carried out during the period mentioned is given in *Table VII* Those referred to in *Table VI* as useful include only those reported as 'benign' or 'malignant'

## EVALUATION OF NEEDLE BIOPSY

**The Case for Needle Biopsy**—The foregoing tables indicate the usefulness of both aspiration biopsy and drill biopsy in the hands of the author, aided by the pathologists, but, as in all types of knowledge, figures, whatever they might prove, do not present or destroy the whole case

In general, the type of case subjected to needle biopsy is one in which, because of lack of bed accommodation, lack of time, or lack of adequate indication in the view of the clinician concerned, a biopsy would not be taken in the ordinary way In other words, much of the evidence provided for the pathologist by needle biopsies would not be available at all if they were not done Moreover, the method is less dangerous in some ways than a biopsy by excision The reason I first decided to try it was because the excision of a malignant cervical gland by a competent surgeon led to the rapid spread throughout the tissues of the neck and in the skin of the neck on to the chest wall, of cancer *en cuirasse*

For the radiotherapist it is very important and much more satisfying to have a histological diagnosis not only of the condition from which the patient is suffering, but also of the lesion which he is treating. Moreover, it has been found by this method that the "sarcoma of bone" was a metastatic carcinoma, a gumma, or a pyogenic infection, that a "malignant gland of neck" was tuberculous, that a "carcinoma of œsophagus" was Hodgkin's disease, that a "retro-peritoneal tumour" was a cellulitic spread from a diverticulitis, that a "mixed parotid tumour" for which operation had been refused was an adenolymphoma, and that a "lymphadenomatous gland" was a metastasis from a carcinoma of the bronchus. Such instances can be multiplied. Apart from these, the number of instances in which a clinical diagnosis is confirmed is sufficiently great, but there is a great number also in which this diagnosis is added to. Such cases are those in which a metastasis, by means of such a biopsy, may have the site of the primary growth defined or indicated for the first time. Again, there are cases in which the surgeon has not been able to make a diagnosis, sometimes even in spite of removing a gland at operation, in which the needle biopsy has provided a diagnosis of infection, reticulum-cell sarcoma, or metastatic carcinoma. In exposing a large gland an enlarged, but smaller, adjacent gland has been removed by eminent surgeons in two instances which I can call to mind, one in the neck and one in the abdomen, with in each case no histological result. The subsequent drill biopsy established a diagnosis in the first case of reticulum-cell sarcoma, probably originating in the suprarenal gland. Another useful feature of the method is that it often determines the presence of pus or of a cystic collection of fluid previously unsuspected.

The method of excising pathological lesions is doubtless, in general, more certain of providing information than is a needle biopsy. If needle biopsy fails to provide adequate evidence, however, surgical biopsy may still be resorted to. Methods of non-surgical treatment of cancer are being increasingly used and coincidentally with this there is a tendency to dispense with histological evidence of the nature of the lesion. Results of such treatment, e.g., by œstrogens and radiation, apart from being misleading, will have no standing in international literature without histological evidence of their nature. Histology is still the touchstone of cancer work.

One way in which this method might be of value in radiotherapy and in chemotherapy, apart from verifying the diagnosis, is by facilitating the comparison of the states of the abnormal tissue at different times during treatment by taking serial biopsies.

One case description will help to emphasize the practical value of the method. A female patient had been ill for some months and I was asked to see her with a view to X-ray treatment of the lungs for what was thought by eminent physicians to be a slowly progressing infection of unknown nature, probably a fungus. I saw her at her home at 9 a.m. and, in the clinical examination, found a small gland 1 cm. in diameter deep behind the lower end of the left sternomastoid. She was very ill and I was averse to moving her the five miles to hospital, so I rang

up the physician in charge of the case to ask permission to attempt an aspiration biopsy on the small gland. This obtained, I fetched the necessary apparatus and local anæsthetic and fortunately was able to obtain a small piece of the gland which was diagnosed at 11 a.m. the same morning by Dr. Hermitte as a metastasis of an oat-cell carcinoma of a bronchus.

This illustrates the ease with which such a biopsy can be effected, and in hospital the time spent is not usually more than three minutes from the time of starting to prepare the skin to the time of corking up the specimen tube. The patient's work or treatment need not be interrupted and delay because of bed difficulties is unnecessary.

**The Case against Needle Biopsies**—From the pathologist's point of view it is better to have a big specimen than a small one, and, indeed, pathology and clinical medicine would be less advanced than they are if surgery had not developed as it has. From the patient's point of view, however, the more conservative the treatment the better, provided the effects and results are the same.

There is no doubt that these biopsies are useless if the pathologist is not patient. Especially is patience needed during his first attempts to provide diagnoses from pieces smaller than those he has been used to discarding. The first aspirations having been successful, the next few biopsies attempted were more ambitious and the pathologist wrote "I think the practice should be discontinued." However, he was persuaded to persevere and became enthusiastic. The results obtained since with aspiration biopsy, and to a greater extent by drill biopsy, indicate the usefulness of the method. It must be used with judgement, however, and not as the method of choice in cases more suitable for ordinary biopsies. For instance, a bronchoscopy should be the method of choice to obtain a biopsy from a bronchial carcinoma, but if this fails a drill biopsy may be successful. But if the drill biopsy provides histology which would otherwise be lacking or can save the patient from a major operation, it is justifiable even if the pathologist receives only a small piece of tissue.

## TYPES OF DRILL BIOPSY

The types of drill biopsy carried out were —

**1. Relatively Superficial Soft-tissue Lesions.**—These include cervical, axillary, inguinal, and other lymph-nodes, breast lesions, muscle lesions, and lesions in such situations as the thyroid gland, parotid or other salivary glands, and the orbit. Also regions such as the tonsil and tongue have been drilled when the site of non-ulcerated lesions. Local anæsthesia is easy in such cases, and the procedure is safe and simple.

**2. Easily Accessible Bony Lesions**—These include lesions in all the bones except the vertebræ. The bone is inspected and carefully measured on the radiographs to determine the site of entry to be attempted by the drill, aiming at an active part of the pathological process and ease of approach. If there is an obvious swelling it is very easy of course, but if not, it is sometimes possible to find a point where the cortical bone is thin or destroyed and the needle can easily be pushed into the lesion. If the

Table VII—DRILL BIOPSY REPORTS

No	CLINICAL DIAGNOSIS	BIOPSIES		DRILL BIOPSIES					PRIMARY	REMARKS
		Other Sites	Same Site	Site	Normal	Doubtful	Useless	Benign	Malignant	Type
1381	Breast — Carcinoma			Breast					+	Polygonal-cell carcinoma
O/217	Ca			Breast					+	Poly-cell ca
162	Ca			Breast (1)				+	+	Abscess
286	Recurrent ca			Breast (2)					+	Scirrhous ca
O/54	Rec ca			Nodule in scar					+	Poly-cell ca
A/146	? Ca R			Nodule in scar					+	Poly cell ca
A/637	Ca R			Breast	+					
A/695	Ca R	L breast (-)		R breast					+	Scirrhous ca
A/497	Ca R	L breast (-)		R breast					+	Poly-cell ca
A/869	Ca	Ovarian tumour (-)		Breast					+	Poly-cell ca
1422	Ca			Breast					+	Spheroidal-cell ca
A/380	Ca			Breast					+	Trabecular poly-cell ca
B/244	Rec scar			Chest wall		+			+	Trab poly-cell ca
A/695	Ca			Breast					+	Breast
A/1176	Ca			Breast					+	Breast
B/19	Ca			Breast					+	Poly-cell ca
A/562	Ca			Breast					+	Poly-cell ca
162	Ca			Breast					+	Poly-cell ca
A/439	Ca			Breast					+	Poly cell ca
1424	Bone — ? Hypernephroma			Sacrum					+	Myeloma
121	? Osteoclastoma			Tibia		+			+	Poly-cell ca
815	Ca breast	Forearm (- melanoma)		1st L V						
1523	? Angioma			Mandible						
A/2	? Metastasis from melanoma			Iliac bone					+	Osteoclastoma
A/811	Osteoclastoma			Iliac bone					+	Poly-cell-like squamous cells
A/649	Metas from prostate			Upper end of femur					+	Colligative necrosis
A/634	? Osteoclastoma			Os calcis						Myeloma
A/612	Secondary ca femur primary ? hypernephroma			Iliac bone					+	Osteoclastoma
A/567	Osteoclastoma			Rib		+				Poly-cell ca
A/839	Bronchial neoplasm ? metas			Sacrum (1)						?
A/862	Sacral tumour			Sacrum (2)						Tubercle
A/1080	? Osteoclastoma			Sacrum (3)						Osteomyelitis
A/1085	Osteoclastoma			Radius				+++		Osteoclastoma
A/340	Chondroma ? malignant			Tumour of ilium						Chondroma
B/74	? Sarcoma femur			Shoulder		+				? Inflamm
B/31	Pathological fracture clavicle			Shoulder						Purulent granulation tissue
A/371	Osteoclastoma tibia			Femur						Pycogenic gran tissue
A/962	Unknown lesion tibia			Clavicle					+	Osteoclastoma
B/122	Ca cervix	Cervix ca		1 Tibia					+	Malignant osteoclastoma
A/1207	Ca bladder ? metas	Bladder ca 15 yr		2 Tibia					+	Structureless jelly like ca cervix
				Tibia		+				Small cells malign like ca cervix
				Pubis					+	Muscle only
				Clavicle			+			Not

Diagnosis later, duodenal ulcer

Due to artefact

23 days interval

Unknown primary

## 245

[illegible]



Table VII—DRILL BIOPSY REPORTS—continued

No	CLINICAL DIAGNOSIS	BIOPSIES		DRILL BIOPSIES						PRIMARY	REMARKS
		Other Sites	Same Site	Site	Normal	Doubtful	Useless	Benign	Malignant	Type	
1154	Ca thoracic dermoid	Mediastinum	Neck doubtful	Axilla		+			+	Necrosed tissues	Better than surgical biop
B/10	? Metas Hodgkin's			Neck						? Reticulum cell sarcoma	
A/1046	Retropertitoneal tumour	Anaplastic tu (retrop)		Groin		+				Fibrous tissue	
A/1127	? Hodgkin's	Cerv gland lymphoid follic retic		Groin		+				? Lymphoid follic retic	Diagnosis not possible on drill biopsy
A/1044	Ca cervix	Cervix adenoca		Groin					+	Tubular-columnar cell ca	
B/29	? Ca lung	Breast ca		Neck					+	Poly-cell ca	
O/80	Ca breast			Axilla					+	Poly-cell ca	
B/4	? Ca kidney			Groin					+	Poly-cell ca	
A/1255	Ep ear	Ear ep		Neck		+		+		Chr inflam	
A/1195	Tb gland			Neck						Tuberculosis	
A/1142	? Reticulosis			Neck					+	Retic sar or Hodgkin's	
A/734	? Sc metas (breast)	Breast ca		Neck					+	Fat only	
A/721	Ca tongue			Neck		+				Well diff sq ca	
A/935	? Tuberculosis			1 Neck						Chr inflam with granuloma	
A/1202	? Tb gland neck			2 Axilla					+	Hodgkin's	
A/1208	Ca epiglottic fold			Neck		+				Blood and neutrophil leucocytes	
A/435	Ca tonsil			Cerv gland					+	Poly column tubular ca	
A/1263	Ca tongue	Tongue— (1) Failed (2) Ca		1 Neck 2 Neck					+	Necrotic sq cell ca	
A/1138	Hodgkin's			Neck					+	Ghosts of poly-cell ca	During tr 3/12 after tr
A/1086	? Ca in gland and tubercle		1 Tubercle 2 Carcinoma	Neck					+	Poorly diff sq ca	
A/423	Malign melanoma foot	Foot malign melanoma		Groin					+	Poly-cell ca pharynx or lung	
A/535	? Ca metas in gland			Neck						Sq cells	
A/354	Ca tongue	Tongue sq ca		Neck		+			+	Malign melanoma	
1384	Ca nasopharynx			Axilla					+	Chr inflam	
A/1431	? Hodgkin's ? Ca bronchus			Axilla					+	Sq-cell ca	
1371	Ep anus			Groin					+	Poly-cell ca	
A/322	? Ca ovary ? Metas ca ? Dermoid			Axilla		+			+	Sph - or poly-cell ca	
1529	Cerebral tumour			Neck					+	? Lymphosarcoma	
A/159	Ca tongue	Tongue sq ca		Neck					+	Sq ca	
962	Ca lung			Neck					+	Small poly-cell sq ca	
A/67	Mediastinal tumour			Neck					+	Oat-celled ca	
A/529	Reticulosis			Axilla					+	Ret sar	
A/228	Ca lip			Submax					+	Sq-cell ca	
A/956	Ca breast	Lip sq ca		Neck					+	Vol muscle and nerve	
A/909	Ca esophagus	Breast ca		Neck			+		+	Hodgkin's dis	
A/861	Ca larynx			Neck					+	Sq ca	
A/663	Mass in neck			Neck					+	Sq ca	No primary yet found
1252	Ca fauces		Adenocarcinoma (4 yr before)	Neck					+	Sq ca	Reviewed
O/33	1 Inguinal gland		Adenocarcinoma (4 yr before)	Groin					+	Adenoca	
	2 Inguinal gland		Adenocarcinoma (4 yr before)	Groin				+		Endometriosis	Decided endometriosis subsequent development suggests malignant

[illegible]

Table VII—DRILL BIOPSY REPORTS—continued

No	CLINICAL DIAGNOSIS	BIOPSIES		DRILL BIOPSIES						PRIMARY	REMARKS
		Other Sites	Same Site	Site	Normal	Doubtful	Useless	Benign	Malignant		
1482 A/127 A/108 A/320	Endometriosis Tumour lower abdomen Ca testis ? Ca bladder ? Ca prostate			Umbilicus Lower abdomen Abdom tu Pelvic mass		+		+	+	Endometrioma Poly-cell ca Sq ep	? Suprarenal cortex   ? Ca ovary
1343 A/557 A/857 A/820	Antrum — Ca L antrum Ca antrum Ca antrum Ca antrum			L antrum Antrum Antrum Antrum		+		+++	+++	Necrosed tissue Large poly-like sq cell Sq-cell ca Sq ca	Diagnosis not certain
A/1011 A/929 A/328 *B/269 *B/79	Intrathoracic — Ca lung Ca lung Sarcoma chest wall ? Metas lung Ca bronchus Chondro osteo sarcoma			Lung Lung Lung Lung Lung				+++ + +	+++ + +	Poly-cell ca ? Ca ? Endothelioma Seromyosarcoma or fibrosarcoma Spheroidal and spindle-celled ca Mostly fibrous tissue with numerous trabeculae of imp bone and osteoid tissue, little chondroid tissue. One tube lined with flattened and cubical epithelial cells in middle Purulent necrosed lung tissue containing centrally laminated necrosed nodules No neoplastic tissue Pieces of tissue like normal liver Sq celled ca Polygonal cells and tubules of columnar cells Very fine specimen	? Lung  Thymus Jaw
*B/379	C1 lung			Lung			+				
*B/551 *B/341 *B/227	? Ca lung Ca lung Ca bronchus			Lung Lung Lung			+		++		? Lung or bronchus
*161 *162 *163 *164 *165 *166 *B/594 *A/1175	Prostate —  All these cases were under treatment by stilbæstrol						+		+	Voluntary muscle and fibrous tissue No prostatic tissue Possibly myo adenoma of prostate No ca Col tubular poly-cell ca prostate Involuntary muscle No acini No abnormality Fibrous tissue with involuntary muscle-fibres No acini Suggestion of chronic inflammation of fibrous tissue Col tubular poly-cell prostate Solid polygonal celled ca	

Tu fixed to rib					Breast L size
				No actino poly cell ca	
				Secondary ca	
				Sq cell	

cortical bone is dense I drill a hole in it with a bone drill worked by hand and then push the hollow needle through the same hole into the lesion

### 3 The Vertebrae —

The *cervical vertebrae* almost belong to the last group, but obvious precautions are taken to avoid the vertebral artery, the spinal cord, and nerve-roots

The *dorsal and lumbar vertebrae* are more difficult. The neural arches are easily accessible but not often affected. The bodies are deeply situated

radiographs were made with a portable machine, correction may be necessary for the divergence of the beam in determining the distance from the midline of the point to be aimed at. The lesion usually feels firmer than the lung through which the drill is passed. When the firmer tissue is reached, the trocar is removed and drilling commenced. The heart, aorta, and superior vena cava are all, of course, structures to avoid, but with rational confidence in one's judgement, accidents do not occur,

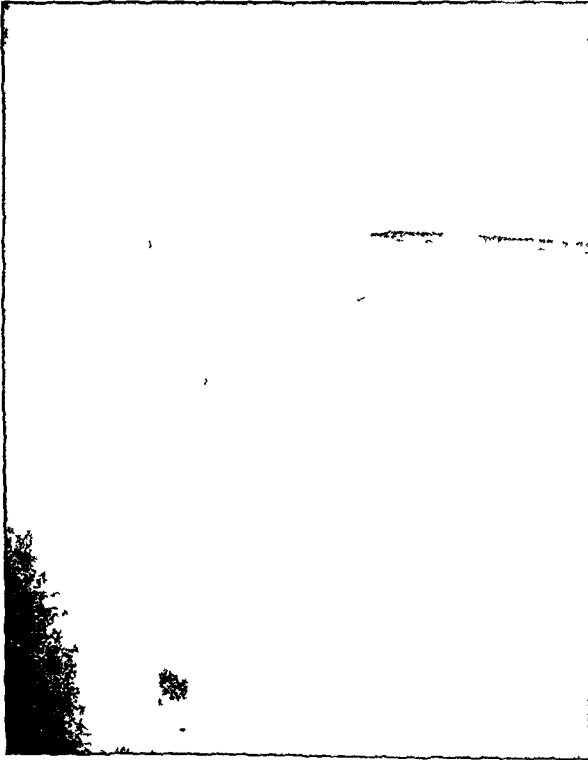


FIG 340 — Needle incorrectly placed

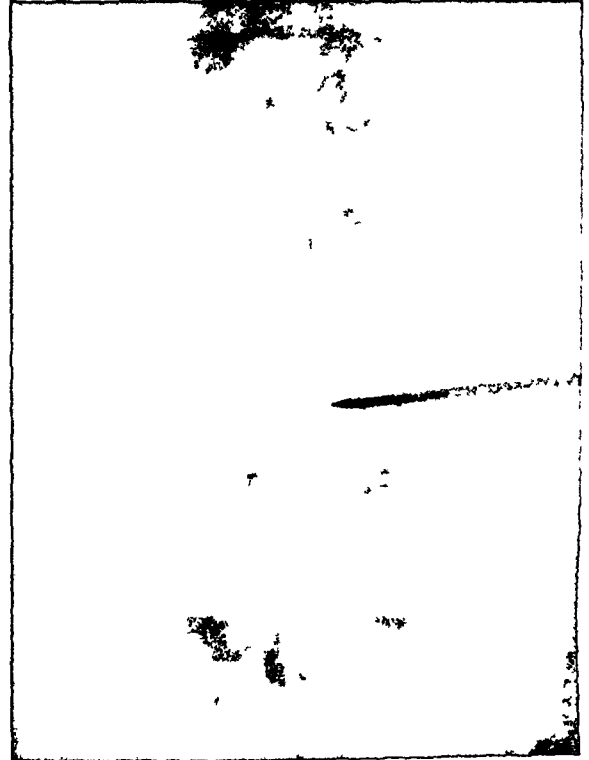


FIG 341 — Needle correctly placed

From lateral radiographs taken with a marker on the skin in the midline, the depth (6–8 cm usually) of the lesion from the skin can be measured. If the drill is then inserted through the skin at an equal distance from the midline at an angle of  $45^\circ$  to the vertical with the patient lying prone, it is not difficult to strike the lesion. This procedure is best carried out under light general anaesthesia and with facilities for radiographic verification of the position of the drill. Pentothal is adequate with premedication and efficient radiography (see Figs 340, 341). A grid used on the back for an anteroposterior radiograph with the patient supine helps to decide on the level to insert the drill through the skin (Fig 342).

**4 Intrathoracic Lesions** — In a radiograph the ribs form adequate markers for the chest, and by drawing lines from front to back it is possible to determine the direction in which the drill should be passed to the lesion. The patient should be in the same position as when the radiograph was taken. The distance from the midline is easy to determine, but in some cases, especially if the

although the proximity of the heart or aorta may cause alarming excursions of the free end of the drilling needle. Local anaesthesia is often adequate, but a general anaesthetic more comfortable.

**5 Intra-abdominal Lesions** — These cause most trepidation unless there is a large tumour reaching the surface. It is necessary to judge if the tumour is retroperitoneal, in which case it may be reached through the back, or, in the case of a pelvic tumour, extraperitoneally by passing the needle below Poupart's ligament into the tumour.

The tumour may sometimes reach the surface of the abdomen over only a small area. It is possible sometimes to push the bowel out of the way. Only when sure that the tumour can be punctured without the risk of going through bowel should the drill be inserted. In this way a biopsy can be obtained without difficulty with novocain anaesthesia in many patients. In one patient with a tumour between the liver and the kidney I adjudged it safest to penetrate the tumour by going through the liver, the resultant biopsy changing the diagnosis from Hodgkin's

disease to neurofibrosarcoma. In another case a retroperitoneal tumour sent for radiotherapy proved to be a hydatid cyst.

**6 Prostatic Lesions.**—These are best dealt with in the lithotomy position. It is necessary to have the left index finger in the rectum. The needle is inserted through a small stab in the skin of the perineum, with the patient anesthetized (preferably general). The needle is easily felt, and can be guided into the prostate. The trocar is then removed and drilling commenced.

### TECHNIQUE

The techniques of the methods employed in this series of cases are different for aspiration biopsy and drill biopsy from the point of view of obtaining the tissue, and there are slight differences in the treatment by the pathologist of the material obtained.

**Aspiration Biopsy.**—The technique for obtaining the tissue is the same as that described by Martin and Ellis (1930).

A sharp hollow needle with an internal bore of about 1.5 mm diameter is attached to a 20-c.c. syringe with a closely fitting piston. The tumour is fixed, if necessary, by the left thumb and index finger (e.g., in the case of an accessible tumour such as a lymph-node, breast tumour, or similar lesion).

Local anaesthesia is used intradermally at the intended point of puncture and interstitially as required to render the procedure painless, at the discretion of the operator. A small puncture is made with a scalpel (since otherwise a disk of skin may be punched out by the needle and block it). The needle is introduced through the skin into the tumour and then the piston is withdrawn, producing suction by the syringe. Keeping the piston withdrawn in this way by means of the forefinger of the right hand braced against the end of the barrel of the syringe, the needle is pushed through the tumour and then withdrawn 1 or 2 mm before pushing it again in a different direction. This manoeuvre serves to cut off the thread of tissue in the syringe. Without withdrawing the needle from the tumour the process can be repeated two or three times. Then the suction is partly released and the needle withdrawn from the tumour. Complete release of suction may result in the tissue being left in the tumour. When the needle is being withdrawn from the skin the tissue may remain in the needle or be sucked into the syringe, which is filled with air and used to expel the tissue into a suitable tube. If the tissue is sucked into the syringe the pieces are best picked out with the scalpel and put into the specimen tube. If the pieces are very broken up, however, the syringe is best rinsed out vigorously with the formalin solution which is used as a fixative. The formalin is put into the specimen tube, which is then ready to go to the laboratory.

**Drill Biopsy.**—The technique is the same except that a squared-off needle of the type shown in Fig 339 is used, the free end being bevelled and sharpened. This is introduced, using a pointed trocar, till it reaches the tumour. Then the trocar is removed and the end of the needle fixed in the chuck of a dental drilling machine. This is made to turn by an assistant or by the operator using the treadle of the machine. While it is rotating the

needle is pushed steadily in a straight line into the tumour. When the limit of the tumour is reached the needle is withdrawn about 2 mm and then, still rotating, pushed forward again in a different direction so as to cut off the thread of tissue. A syringe is then attached to the needle and suction applied during the withdrawal of the needle. The

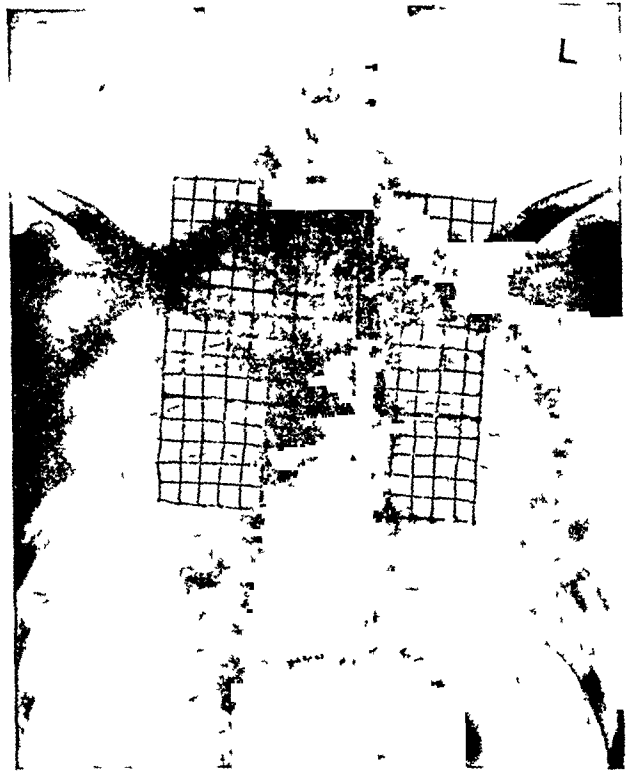


FIG 342—Wire grid used for localizing a spinal lesion. It is fixed to the skin of the back with strapping, therefore there is little distortion due to divergence of the X-ray beam.

thread of tissue may remain in the needle, but more frequently is sucked into the syringe. Its transfer to the specimen tube is effected as for aspiration biopsy.

**Histological Technique.**—This may be aimed at staining a fresh specimen or at providing a paraffin block. These methods are described elsewhere (Hermitte and Ellis\*). The paraffin block method has been followed almost entirely in this series. Three methods have been used. Dr Hermitte receives the specimen in a centrifuge tube and after centrifuging carries through the dehydration and embedding of the tissue in the tube, the block forming a cast of the centrifuge tube with the specimen at the top. Centrifuging is carried out at all stages of dehydration and the first two paraffins. Dr Barrie receives the specimen in a flat-bottomed tube, in which it is allowed to settle. Dehydration and embedding are carried out in this tube, the block forming a cast with the specimen in the surface corresponding to the bottom of the tube. These pathologists have dealt only with aspiration biopsies. The technique used by Dr Woods at the London Hospital has consisted in receiving the specimen in a

\* Section in *Recent Advances in Pathology* (In the press)



FIG 343—Adeno-basal cell epithelioma below right orbit



FIG 344—Fibrosarcoma

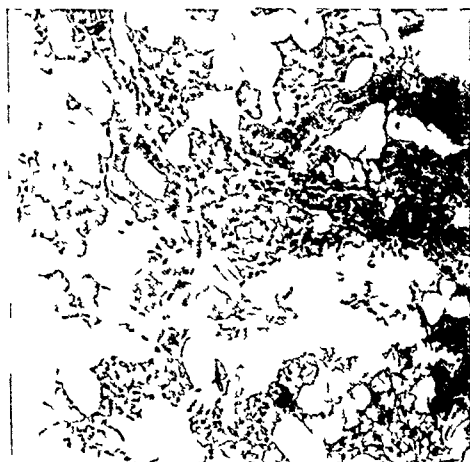


FIG 345—Normal parotid salivary gland

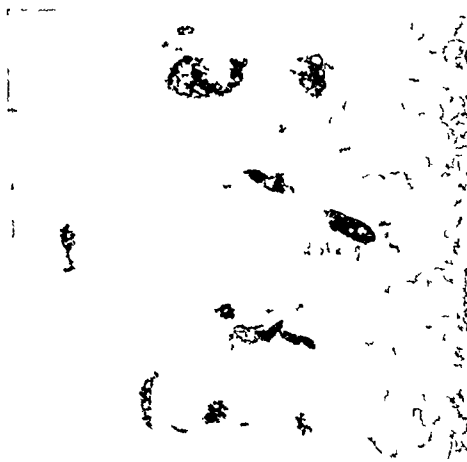


FIG 346—Scirrhus adenocarcinoma of breast

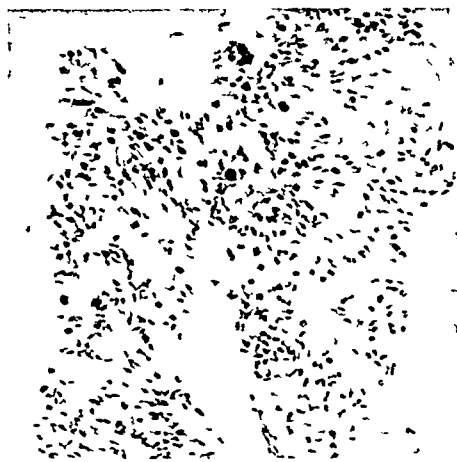


FIG 347—Pleomorphic fibro sarcoma aspirated from biceps swelling

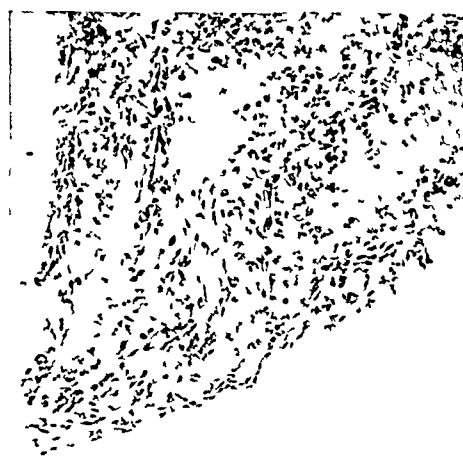


FIG 348—Granulation tissue aspirated from subacute inflammatory lesion of floor of mouth ( $\times 104$ )



FIG 349—Portion of aspirated cervical lymph-node showing typical changes of Hodgkin's disease including several Dorothy Reede cells ( $\times 104$ )

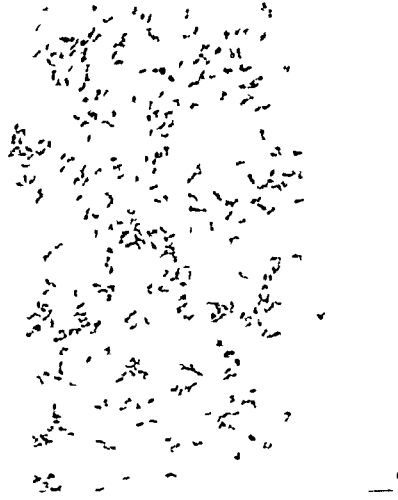


FIG 350—Portion of neurinoma of spinal nerve aspirated from swelling near angle of jaw, and showing typical palisading of nuclei of Schwann cells ( $\times 104$ )



FIG 351—Basal-cell cylindroma aspirated from growth of temple ( $\times 104$ )



FIG 352—Grade 3 squamous epithelioma ( $\times 104$ )



FIG 353—Grade 2 squamous epithelioma ( $\times 104$ )



FIG 354—Grade 3 squamous epithelioma ( $\times 104$ )



small jar with a screw top. The pieces of tissue are picked out from it, dehydrated, and embedded in the usual way. The specimens thus dealt with have for the most part been from drill biopsies, which may be dealt with more easily, occasionally, however, centrifuging of the fixative has been

To facilitate this it is wise to have about  $\frac{1}{2}$  c.c. of 3.8 per cent sodium citrate solution in the syringe to prevent clotting. If the citrated blood is then expelled on to a filter paper, the specimen of tissue can easily be picked out. Sometimes a swelling may prove unexpectedly to contain pus or fluid. A little

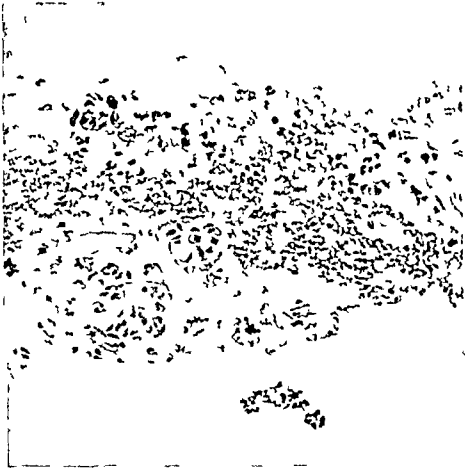


FIG 355—Caseous tissue (top) and tuberculous follicles with giant cell system (bottom). T.B. ( $\times 104$ )

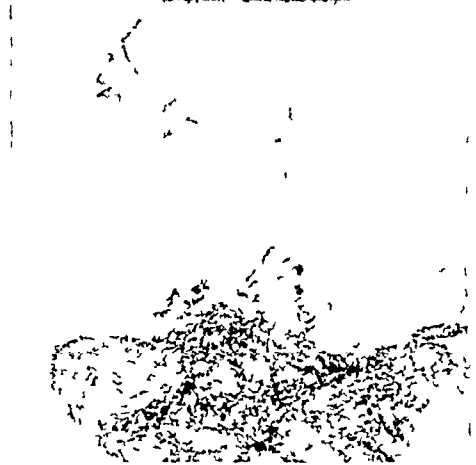


FIG 356—Adenocarcinoma invading abdominal operation scar ( $\times 104$ )

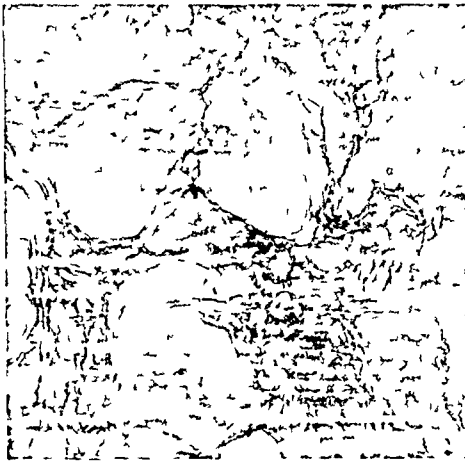


FIG 357—Aspiration from myxochondroma of head of humerus ( $\times 104$ )

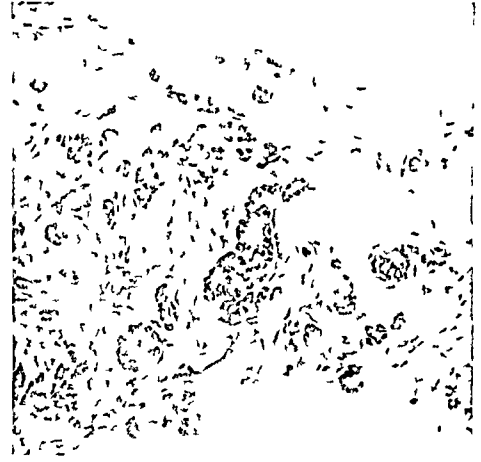


FIG 358—Metastases of breast carcinoma aspirated from sternum ( $\times 104$ )

FIGS 355-358—ASPIRATION BIOPSIES

required to obtain the specimen. The block having been obtained, it is cut in the usual way and sections stained as decided by the pathologist.

**Complications of the Clinical Technique**—These are of two types—those concerning the welfare of the specimen and those concerning the welfare of the patient.

The commonest difficulty is the presence of blood in the syringe. A relatively small amount of blood suffices to hide the specimen. The blood can easily be fixed, embedded, and cut, when a cellular specimen can easily be picked out under the microscope after staining. It is better, however, to pick out the specimen before sending it to the laboratory

pus or fluid can be put into a sterile tube for bacteriological examination and the rest treated as a histological specimen.

*Complications affecting the welfare of the patient* may be immediate or develop later.

Immediate complications are rare. Two cases only of this series suffered any immediate complication. One of these was a middle-aged woman with a lymph-node tumour in the left lower cervical region. In carrying out the aspiration biopsy with an excellent syringe, my forefinger slipped and the piston shot into the barrel of the syringe, driving the needle deep into the carotid artery and shattering the syringe. Blood spurted through the needle under

considerable pressure but on withdrawing the needle and applying pressure at the site of puncture the bleeding rapidly ceased and did not even cause a

hematoma. The second was a man of 50 with superior mediastinal obstruction and severe emphysema. After a painless and bloodless aspiration biopsy

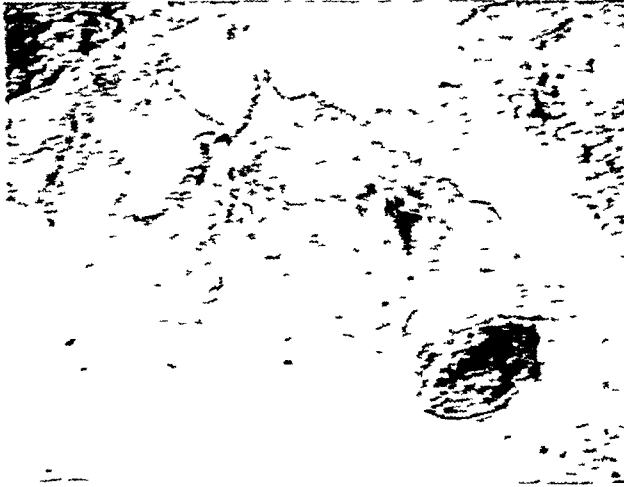


FIG. 374.—Metastatic carcinoma. ( $\times 400$ )

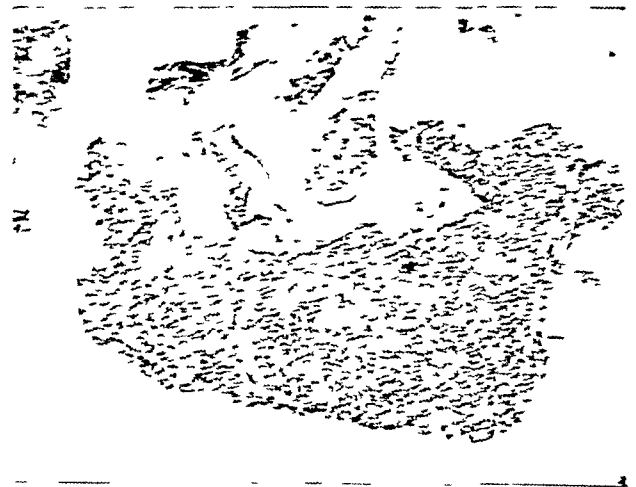


FIG. 375.—Teratomatous. ( $\times 250$ )

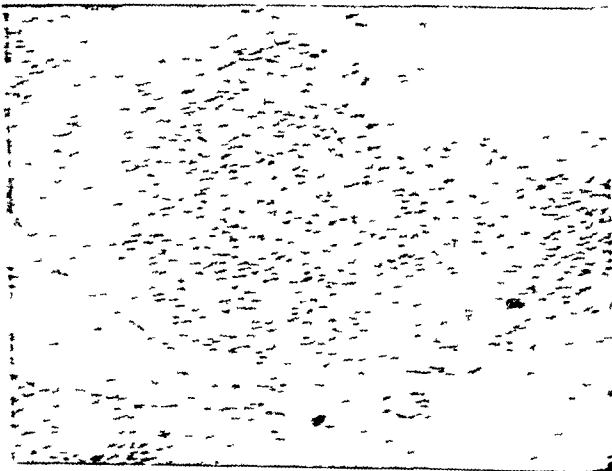


FIG. 376.—Secondary carcinoma in lymph-node. ( $\times 25$ )



FIG. 377.—Prostatic carcinoma. ( $\times 25$ )

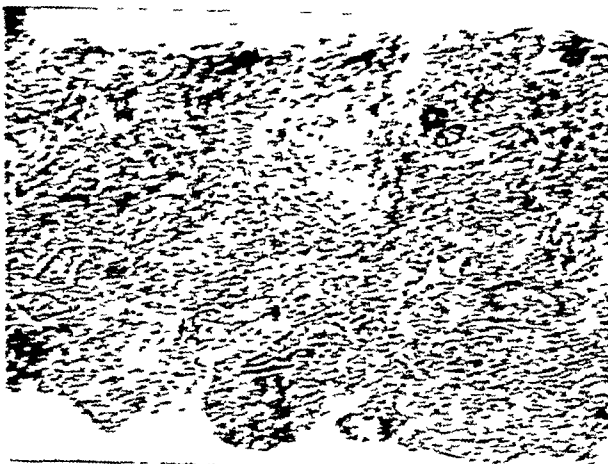


FIG. 378.—Carcinoma of lung. ( $\times 50$ )

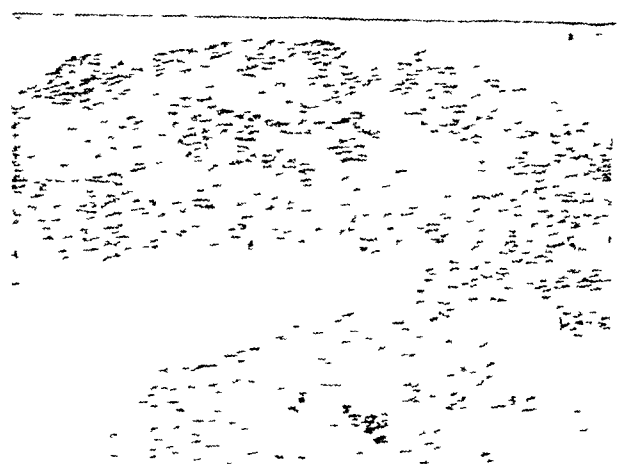


FIG. 379.—Adenocarcinoma of parotid gland. ( $\times 250$ )

under local anæsthesia of a tumour of the left lung the patient rapidly became distressed in his breathing and died within fifteen minutes. The cause of death

was collapse of the punctured lung due to rapid development of a pneumothorax, aggravating the superior mediastinal obstruction. This had occurred

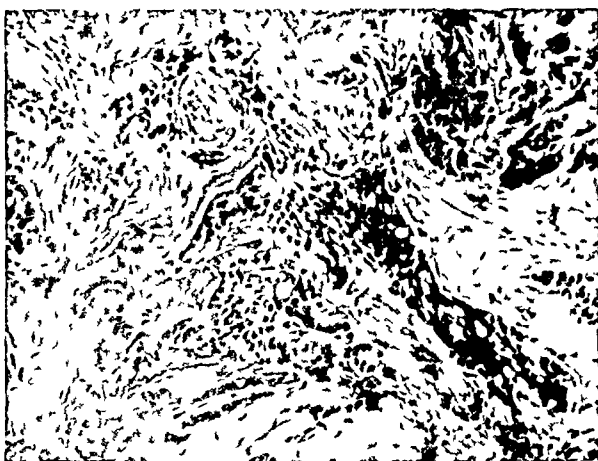


FIG 365—Scirrhous carcinoma of breast ( $\times 97.5$ )

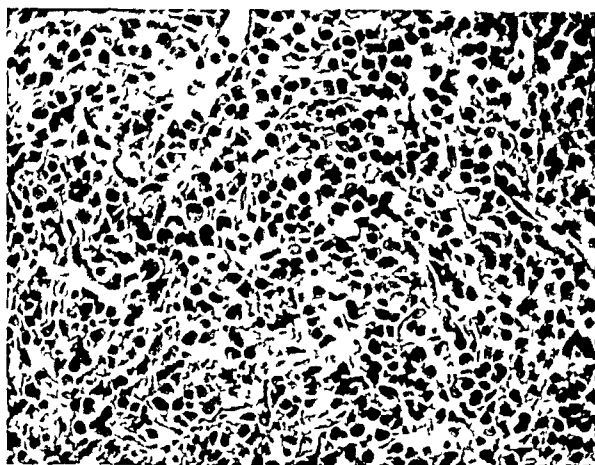


FIG 366—Myeloma ( $\times 240$ )

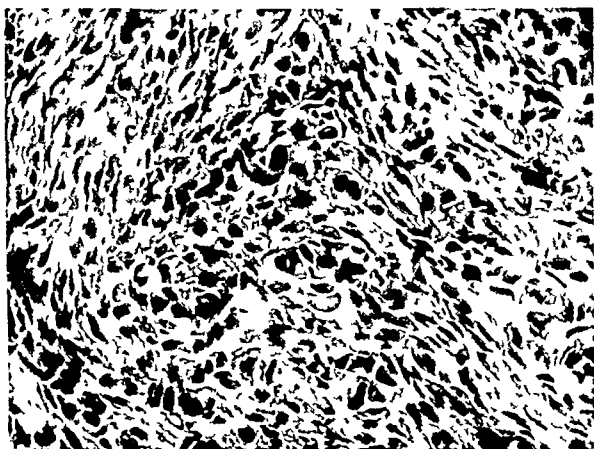


FIG 367—Carcinoma ( $\times 232.5$ )

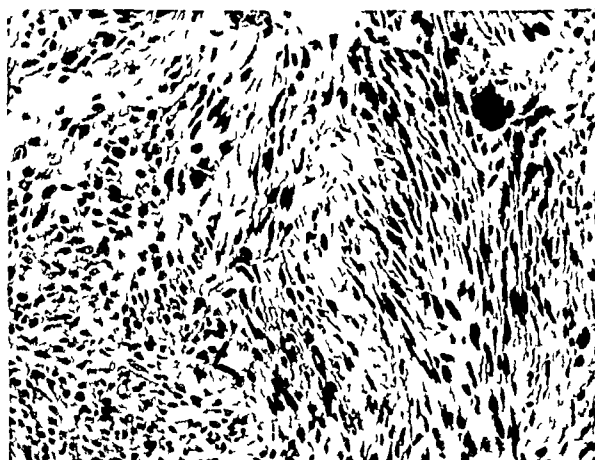


FIG 368—Sarcoma ( $\times 165$ )

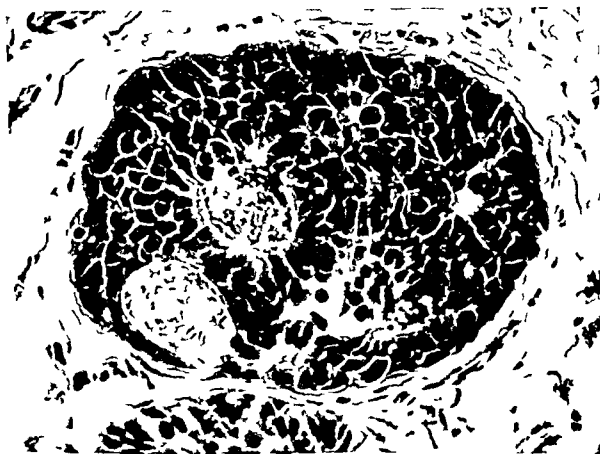


FIG 369—Breast Solid polygonal-celled carcinoma ( $\times 262.5$ )

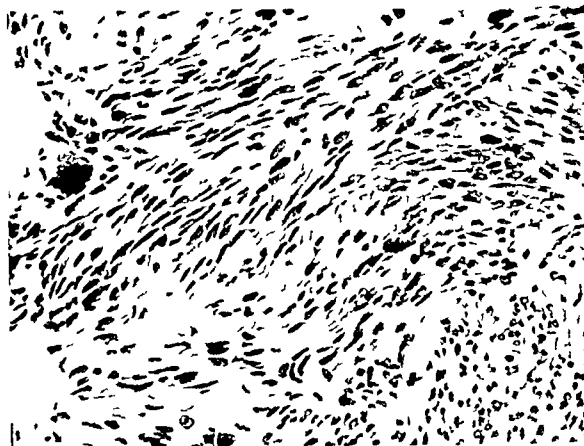


FIG 370—Retrohepatic tumour Neurofibrosarcoma ( $\times 172.5$ )

FIGS 365-370—DRILL BIOPSIES

because the puncture of the lung had rapidly developed into a tear owing to its emphysematous condition. If I had realized the cause in time, death might have been averted.

Late complications experienced comprise two only. One of these concerns a woman with carcinoma of the breast, one of the very few of these biopsies not carried out by me. During the two

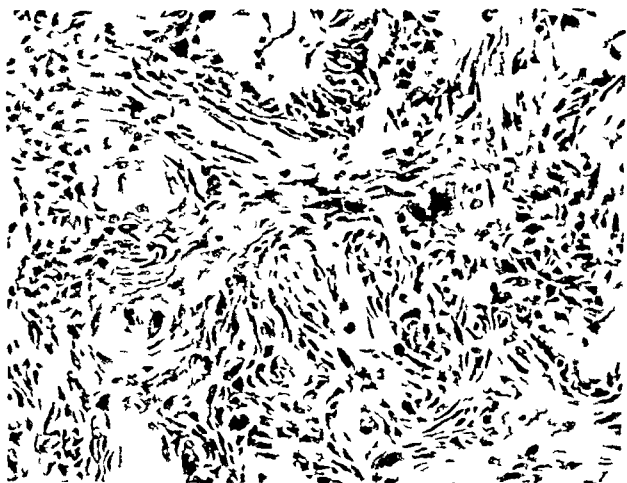


FIG 371 —Gland of neck Squamous-celled carcinoma (150)



FIG 372 —Gland of neck Squamous celled carcinoma (49.5)

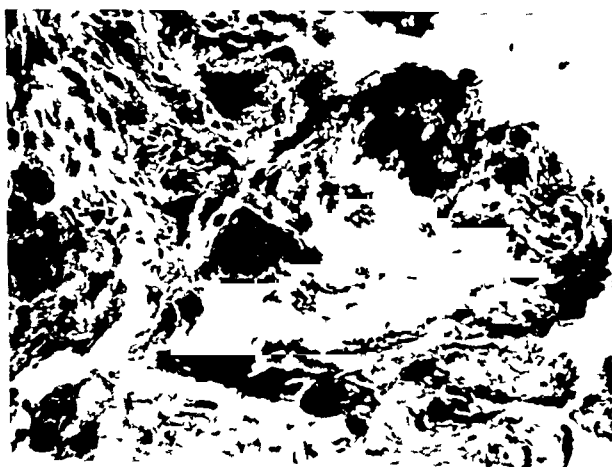


FIG 373 —Gland of groin Melanoma (157.5)

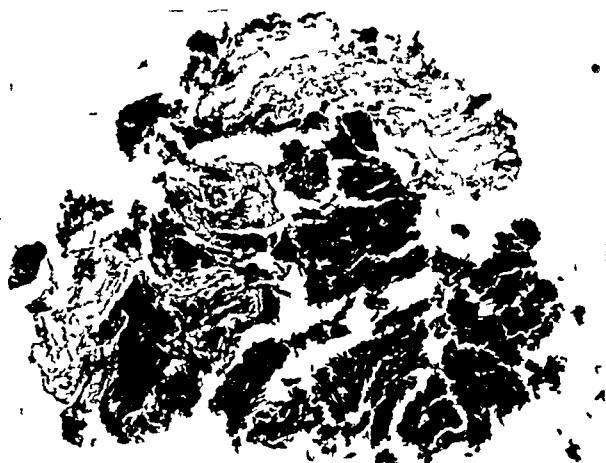


FIG 374 —Melanoma (55.5)

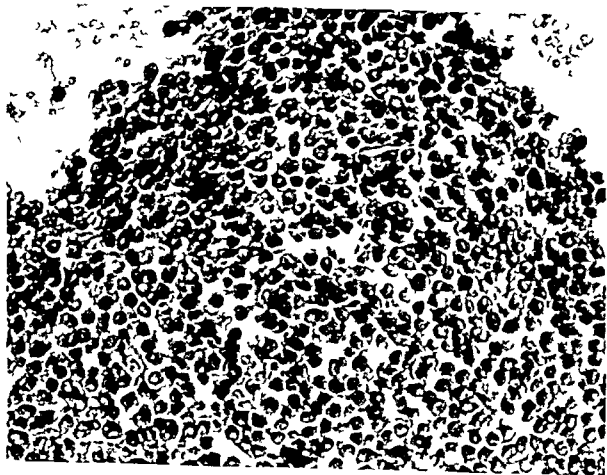


FIG 375 —Bone Ewing's tumour (232.5)

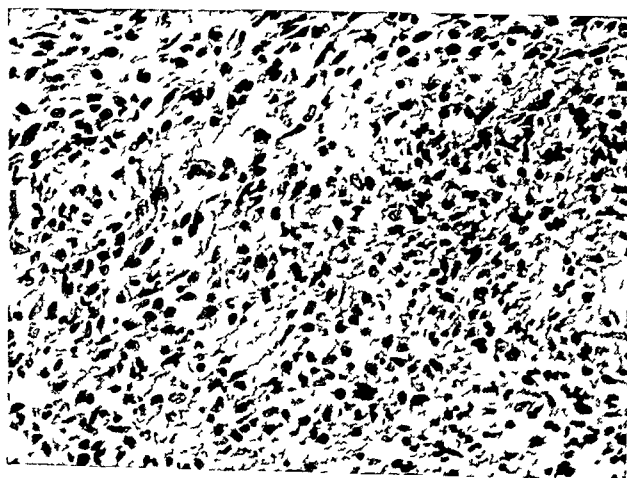


FIG 376 —Gland of neck tuberculosis (225)

weeks following the puncture the patient developed an acute infection spreading from the site of the puncture, the skin sloughing over a large area. The

culture from this showed the infection to be diphtheritic, the operator in this case being a previously unsuspected carrier. The patient made a perfect



FIG 377—Hodgkin's disease ( $\times 337.5$ )

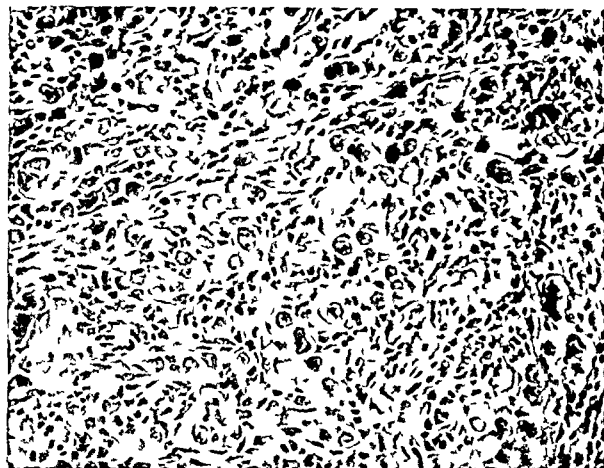


FIG 378—Hodgkin's disease ( $\times 169$ )

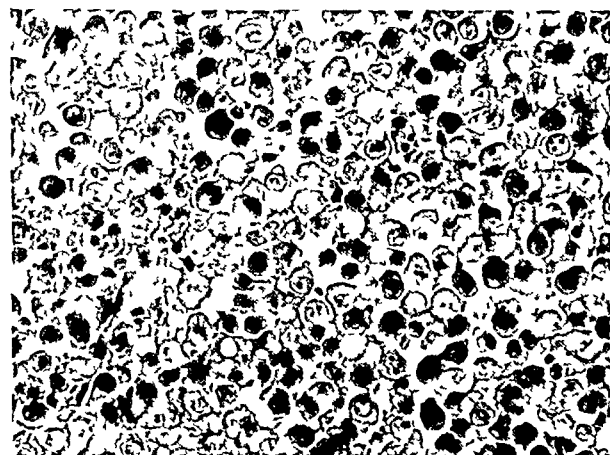


FIG 379—Secondary carcinoma of gland ( $\times 262.5$ )



FIG 380—Parotid ( $\times 180$ )

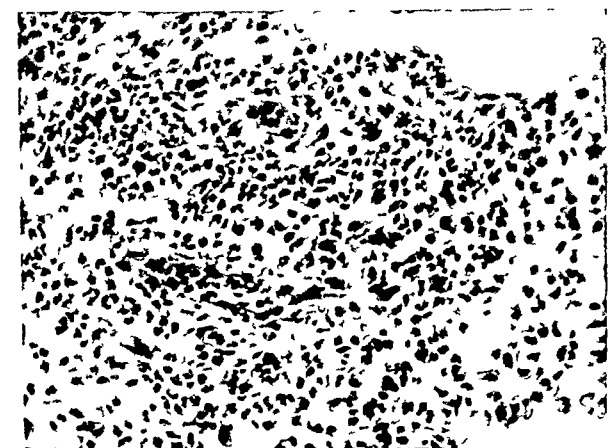


FIG 381—Femur Pyogenic granulation tissue ( $\times 247.5$ )



FIG 382—Femur Pyogenic granulation tissue ( $\times 50$ )

recovery. The other concerns a man of about 65 with a shadow of long duration in the mid-zone of the left lung. I was asked by the physician in charge

to carry out an aspiration biopsy. This was done under evipan anaesthesia with the patient in his bed. The tumour was encountered, as usual, at the first



FIG 383—Osteoclastoma ( $\times 33$ )

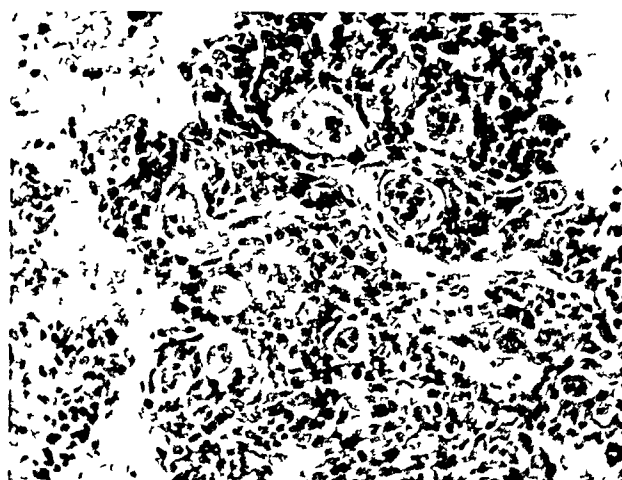


FIG 384—Osteoclastoma malignant

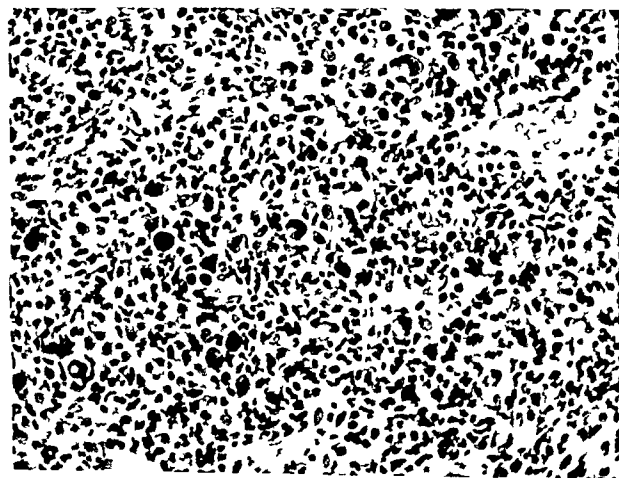


FIG 385—Cervical gland Hodgkin's disease ( $\times 172.5$ )

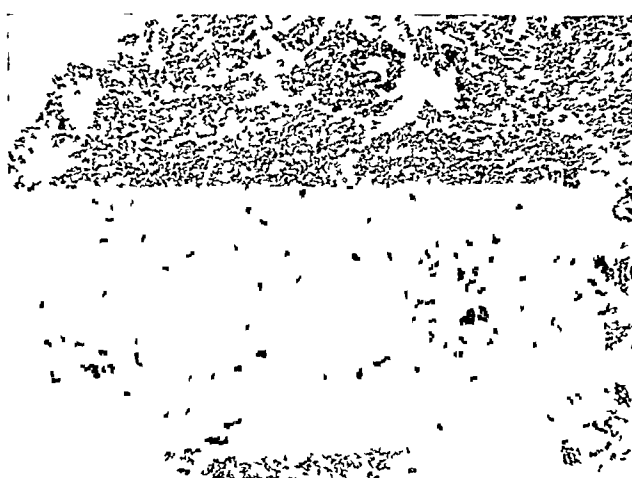


FIG 386—Gland of neck Hodgkin's disease ( $\times 33$ )

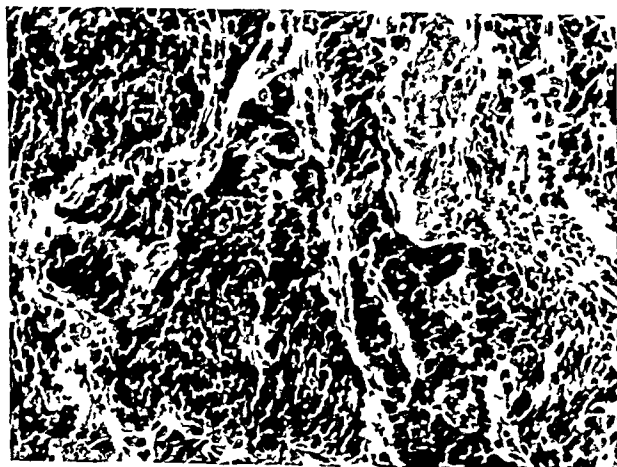


FIG 387—Liver Secondary carcinoma of lung ( $\times 210$ )



FIG 388—Liver Secondary carcinoma of lung. Low-power view of Fig 387 ( $\times 42$ )

FIGS 383-388—DRILL BIOPSIES

weeks following the puncture the patient developed an acute infection spreading from the site of the puncture, the skin sloughing over a large area. The

culture from this showed the infection to be diphtheritic, the operator in this case being a previously unsuspected carrier. The patient made a perfect



FIG 377—Hodgkin's disease ( $\times 337.5$ )

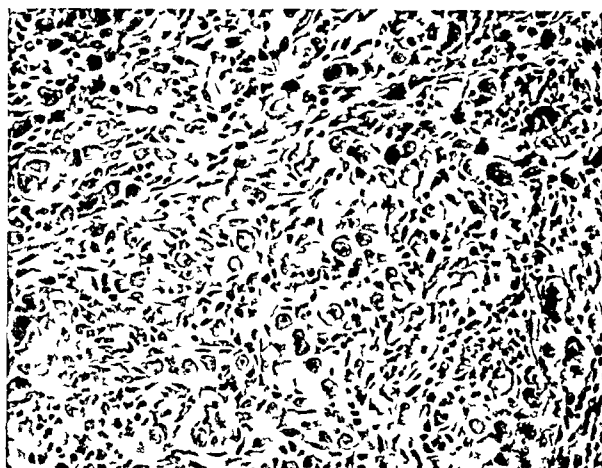


FIG 378—Hodgkin's disease ( $\times 169$ )

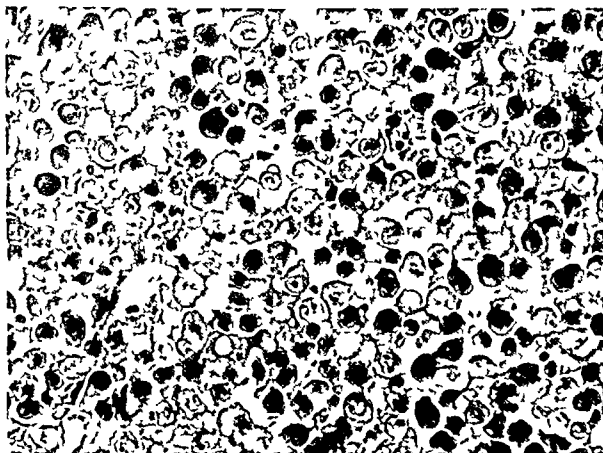


FIG 379—Secondary carcinoma of gland ( $\times 262.5$ )



FIG 380—Parotid ( $\times 180$ )

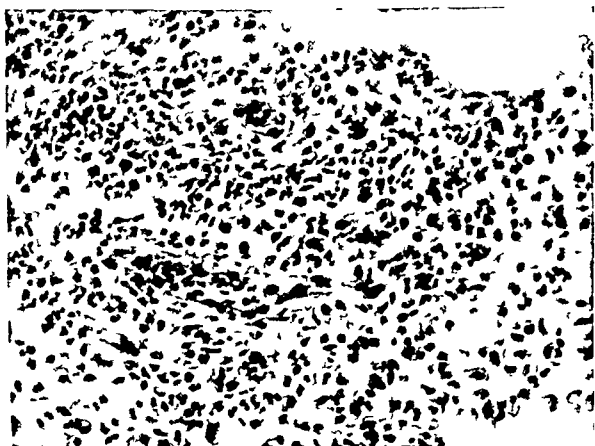


FIG 381—Femur Pyogenic granulation tissue ( $\times 247.5$ )



FIG 382—Femur Pyogenic granulation tissue ( $\times 50$ )



recovery The other concerns a man of about 65 with a shadow of long duration in the mid-zone of the left lung I was asked by the physician in charge

to carry out an aspiration biopsy This was done under evipan anaesthesia with the patient in his bed The tumour was encountered, as usual, at the first

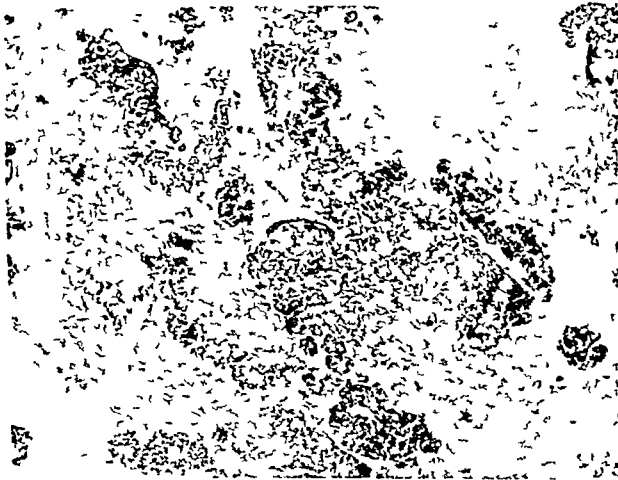


FIG 383—Osteoclastoma ( $\times 33$ )

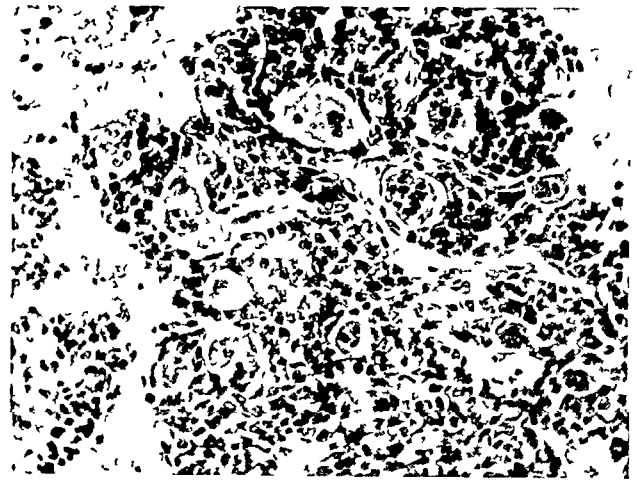


FIG 384—Osteoclastoma malignant

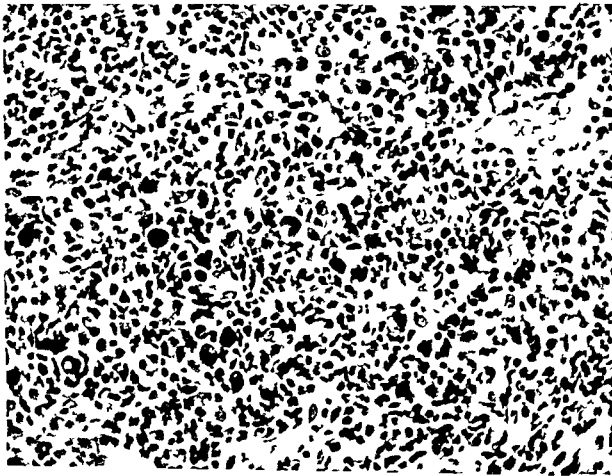


FIG 385—Cervical gland Hodgkin's disease ( $\times 172.5$ )



FIG 386—Gland of neck Hodgkin's disease ( $\times 33$ )

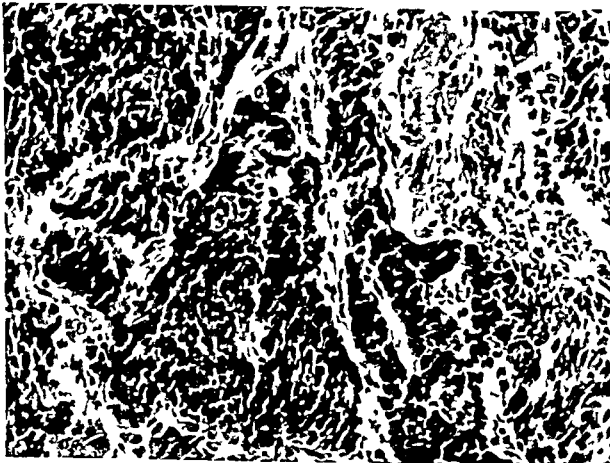


FIG 387—Liver Secondary carcinoma of lung ( $\times 210$ )



FIG 388—Liver Secondary carcinoma of lung Low-power view of Fig 387 ( $\times 42$ )

FIGS 383-388—DRILL BIOPSIES



puncture and thick yellow pus sucked into the syringe. Nothing further was done, but the patient developed signs two or three days later of

a pneumonitis from which he died within two weeks. No other complications have occurred

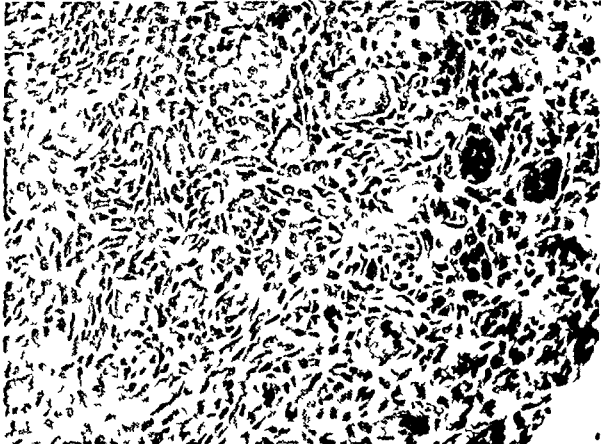


FIG 389 —Osteoclastoma (× 157.5)



FIG 390 —Osteoclastoma (× 30)



FIG 391 —Sarcoma (× 45)

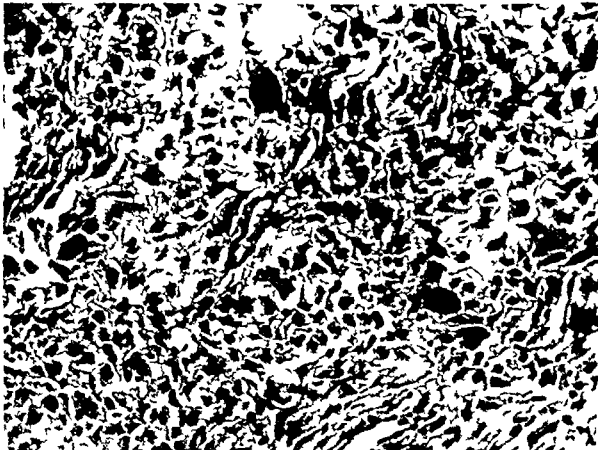


FIG 392 —Tibia Chondrosarcoma (× 180)

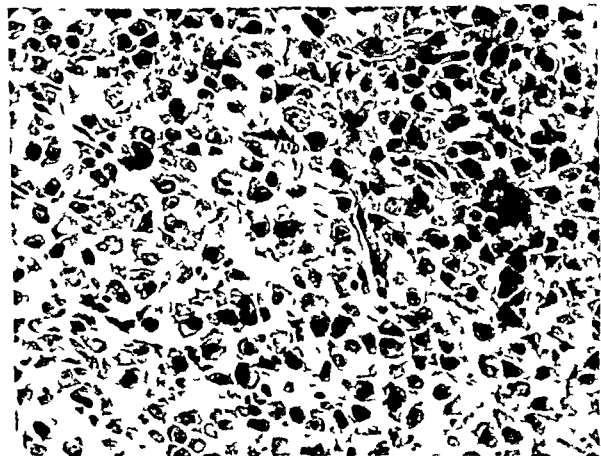


FIG 393 —Thyroid Polygonal-celled carcinoma (× 217.5)



FIG 394 —Carcinoma of thyroid (× 45)

**Technical Advantages of Drill Biopsy over Aspiration Biopsy**—The advantages of drill biopsy in my experience are —

1 The operator has greater control, not having to apply suction at the time of introducing the needle. This is a great psychological advantage, giving more confidence to the operator, and thus making the procedure more widely applicable.

2 A larger piece of tissue is obtained which, besides enabling the pathologist to give a greater number of positive reports, seems to permit also a greater degree of confidence in individual reports.

Both procedures may be carried out equally quickly, although the drill biopsy requires more specialized apparatus.

been responsible for the photographs of the drill biopsies. Miss Wolff helped by finding the fields to be photographed. Dr Walter Shanks, my assistant at the London Hospital, helped with the analysis of the aspiration biopsies. All the members of the staff of a department help in one way or another to make possible any publication, and of others I would like to thank especially the Sister, Miss D Hodgson, and my secretary, Miss Hallett.

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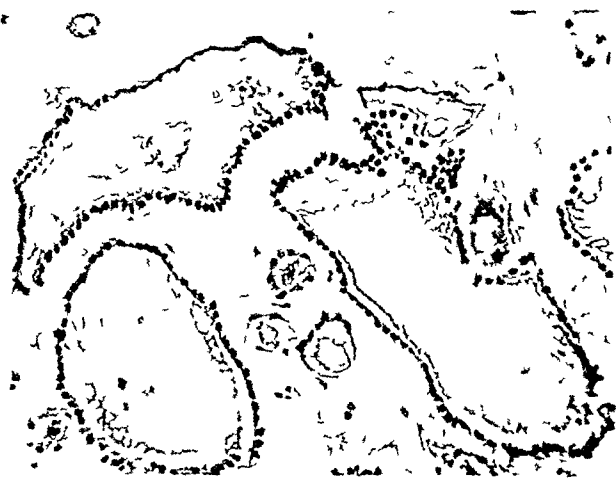


FIG 395—Thyroid gland (150)



FIG 396—Thyroid gland Low-power view of Fig 395 (36)

FIGS 395 396—DRILL BIOPSIES

By using a motor to drive the drill it seems likely that the ease of operation might be increased, the speed of rotation of the drill controlled, and possibly an optimum speed decided upon.\*

In conclusion, I should like to thank all those who have helped to make this account possible, especially Dr Hermitte, Dr Barrie, and Dr Woods, Pathologists at the Sheffield Royal Infirmary, the Sheffield Royal Hospital, and the London Hospital respectively, without whose patience and skill the clinical work would have been useless. Dr Hermitte, who provided the photographs of histological sections of aspiration biopsies, Mr Trent, physicist at the London Hospital, and Mr McOwan have been responsible for producing the drilling needles which I have used, while Mr John King has

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\* Since this article went to press a motor has been used to rotate the drill for months. It is a distinct improvement in technique.

# RENAL ANOXIA AND THE TRAUMATIC URÆMIA SYNDROME

BY SQUADRON LEADER E M DARMADY, R A F V R

PATHOLOGIST TO ROYAL AIR FORCE HOSPITAL, WROUGHTON, AND ROYAL AIR FORCE CASUALTY CLEARING STATION IN ENGLAND

It was the experience of the staff at the R A F Casualty Clearing Station in England that successful surgery was often marred by the onset of uræmia which sometimes proved fatal. The Unit was dealing with casualties evacuated by air from Western Europe and only those cases which were unfit to travel further or which required immediate surgery were admitted to hospital. Among 10,000 casualties admitted there were 44 deaths, and in 12 of these cases death was directly due to renal failure.

As it was felt that an early report might assist in the recognition of similar cases, full details were published of the first 6 of these fatal cases, and of 2 cases in which renal failure was recognized clinically, and which recovered (Darmady et al, 1944).

Biochemical investigations were continued and the present report deals with a further 6 cases of fatal traumatic uræmia and 3 more cases of uræmia with recovery. It is clear that the biochemical course of all the cases and the histological changes found post mortem in the fatal cases are sufficiently similar to warrant the assumption that some common factor was operative in producing the uræmia.

## DESCRIPTION OF THE SYNDROME

The clinical features are characteristic and in the series under consideration all were severely wounded men who had suffered considerable loss of blood, accompanied by shock requiring energetic resuscitative measures. Thus in many cases prolonged periods of hypotension were recorded. Major vessels were involved in the injury in 9 cases and 14 had fracture of long bones. Except for *Case 17*, no crushing injury or undue damage to muscle was observed. Dehydration was particularly noticeable in 3 cases. Blood transfusion had not been given in *Case 15*, the remainder had received Group 'O' blood supplied by the Army Blood Transfusion Service. Transfusion reactions were observed in 3 cases only. Sulphanilamides had been given in 10 cases.

The onset of symptoms took place between the second and sixth day after injury. The first sign was usually anorexia, with a tendency to hiccups, and this was followed in the course of a few days by copious vomiting. The tongue was dry and brown, and the patient was drowsy with attacks of hallucinations. Cyanosis was frequently present. Occasionally a petechial rash was seen over the upper parts of the body. This was thought to be a manifestation of fat embolism (a common feature in severely wounded casualties). During the prodromal period oliguria was present, although this was not always obvious unless a fluid intake and urinary output chart was kept. Anuria developed in *Case 14*. Anæmia was also present, and once uræmia was apparent the blood-pressure was frequently raised (7 cases). The condition of the patient rapidly deteriorated, and within ten days from the injury or exciting cause death occurred. In those cases

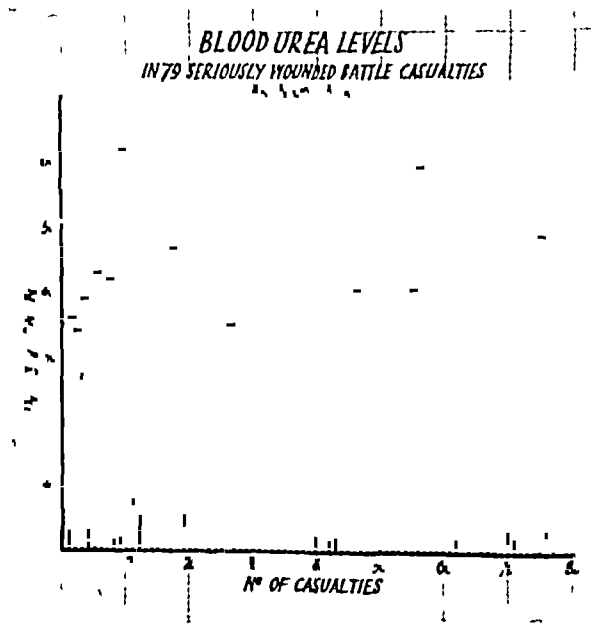
that recovered the sudden improvement was dramatic and occurred about the sixth to the eighth day.

Full details of these cases have been recorded elsewhere (Darmady, 1946).

## BIOCHEMICAL CHANGES

All the cases recorded had an enormous rise in blood-urea, oliguria, and a disturbance of electrolyte balance.

**Blood-urea**—Estimation of the blood-urea is of considerable importance, since it is this which differentiates the case of traumatic uræmia from other severely wounded men. *Fig 397* shows the blood-urea estimations made on 79 seriously wounded casualties. These cases were selected either because they were on the dangerously ill list or had ischaemic limbs. The estimations were carried out on admission to hospital, which was between 2 and 5 days after wounding, at which time traumatic uræmia, if present, would be already apparent. *Fig 397*



*Fig 397*—Blood urea levels, taken on entry, in 79 seriously wounded battle casualties

shows that 28 (35 per cent) had a raised blood-urea, and approximately 60 per cent of the total number examined had a diminution of urea clearance. The highest blood-urea recorded from this series was only 66 mg per cent. In *Table I* it will be seen that the initial values in the 11 cases of fatal traumatic uræmia are on a considerably higher level, and that there is a progressive rise of the blood-urea. This high level may be maintained for several days before death occurs. *Table II* shows the blood-urea from the cases which recovered. In this series the

blood-urea values tend to be lower, and rise to a peak about the sixth to the eighth day, when there is a sudden fall. This fall is sometimes dramatic (*Case 16*) and suggests that a 'crisis' has occurred. The significance of this will be discussed later.

**Oliguria**—This was present in all cases and had some curious aspects, since the volume of urine passed bore a relationship to the intake of fluid. This is shown in *Table III*, where the fluid intake and output is recorded during the first three days that *Case 10* was under observation. The first figure in the intake column refers to the volume of isotonic saline given intravenously, and the second is the amount taken by mouth. In the output column

the first figure is the amount of urine passed, the second the quantity of vomit or of fluid removed by gastric suction. These figures demonstrate clearly the retention of fluid within the body and the relationship of urine secreted to fluid intake. This table also shows other characteristic features of traumatic uræmia. The urinary urea remains constant at values at between 18 and 21 mg per cent in spite of the fact that the blood-urea value swings between 496, 461, and 473 mg per cent. The specific gravity of the urine remained between 1014 and 1018. The pH of the urine did not vary with the alteration in alkali reserve (44–66 vols per cent) but remained at 6.4–6.6–6.8.

*Table I*—BLOOD-UREA FINDINGS IN FATAL CASES OF TRAUMATIC URÆMIA

CASE No	NATURE OF INJURY	DAYS AFTER WOUNDING														
		4	5	6	7	8	9	10	11	12	13	14	15	16	Later	
1	Compound fracture, femur , gunshot wound knee-joint	72	Died													
2	Left forearm and buttock , traumatic amputation of left leg		240	285	Died											
3	Gunshot wound, foot , compound fracture of radius and ulna	68	270	408	Died											
4	Thigh , gas gangrene , <i>Cl septicæ</i>					138	260	424	Died							
5	Compound fracture, tibia and fibula					490	480	600	730	960	1100	720	774	Died		
6	Chest, buttock, and loin , compound fracture of humerus and radius and ulna				103	60	91	148	219	Died						
9	Compound fracture of femur with multiple flesh wounds	91	163	181	156	309		Died								
10	Popliteal fossa , amputation of leg					496	461	473	451	380	336	280	488	520	Died	
14	Muple gunshot wound of abdomen , duodenal fistula			172	296		231	351	Died							
15	Multiple burns		151		Died											
17	Extensive crush injury of leg	85	140	228	263	272	344	296	Died	452						

The progressive rise of blood-urea is seen in 11 fatal cases of traumatic uræmia. This is striking, not only because of the very high levels which may be attained, but because of the ability of the body to survive these levels for several days. The variety and extent of the wounds are noticeable.

*Table II*—BLOOD-UREA FINDINGS IN CASES OF TRAUMATIC URÆMIA WITH RECOVERY

CASE No	NATURE OF INJURIES	DAYS AFTER INJURY																									
		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26			
7	Compound fracture of femur involving vessels				102		148					86				32											
8	Gunshot wound leg neck, chest wall, forearm, and fracture of big toe								86		59														27		
11	Compound fracture of leg traumatic amputation of right leg wounds of thigh and buttock			158	120	112	109	98	61	46																	
12	Fracture of femur multiple wounds of buttocks			91	135	106	95	104	92	72		50	38														
16	Left buttock, left thigh	500	480	820	220	160	124				93					73	50					40					

The blood-urea values in the cases with recovery are on a lower level than those seen in *Table I*. The dramatic fall observed in *Case 16* suggests that a crisis had occurred.

**Disturbance of Electrolyte Balance**—This presents several problems, since not only was there an acidosis but also hypochloræmia. It was easy to alter the alkali reserve by treatment with

Table III—BIOCHEMICAL DATA FROM Case 10

	DAYS AFTER WOUNDING		
	11	12	13
Blood urea (mg per cent)	496	461	473
Alkali reserve (vol per cent)	44	—	64
Intake (oz)	100 80 + 20	100 20 + 80	90 70 + 20
Output (oz)	72 58 + 14	64 60 + 4	66 50 + 16
No. of specimens of urine passed	7	5	9
Specific gravity	1018-1012	1018-1012	1018-1012
Urinary urea (mg per cent)	21-18	19-18	19-18
pH	6.4	6.6-6.8	6.6-6.8

The haemoglobin from Case 10 is shown on the eleventh, after wounding (Table III). The first figure refers to the volume of iso-ly and the second is the amount taken by mouth. In the output column the first figure is the amount of urine passed, the second the quantity of fluid vomited or removed by gastric suction. The retention of fluid within the body is noticeable. Each specimen of urine passed was tested separately for specific gravity, pH, and urinary urea. The figures recorded represent the maximum variation each day.

of the leg was done after resuscitation with three pints of blood and four pints of plasma. Post-operative shock was treated with a further two pints of blood. On the third day after wounding his blood-urea was 91 mg per cent (Fig 398). On the fourth day after wounding he was transferred to the R A F Hospital. He was hiccupping, and it was found that his serum alkali reserve and his blood-chlorides were subnormal. 1000 c.c. of  $\frac{1}{2}$ -mol sodium lactate were given, and there was an immediate and dangerous swing from acidosis to alkalosis. This was corrected with 1500 c.c. of isotonic saline daily given by mouth, but in spite of this there was a progressive rise of blood-urea, which reached 303 mg per cent on the day before death.

Case 10—C S M E showed the difficulty of maintaining the electrolyte balance. He was admitted on the tenth day after receiving a through-and-through wound of the popliteal fossa with a compound fracture of the femur. There had been severe and prolonged shock immediately after wounding and he had received extensive resuscitation. On admission he was cyanosed, his tongue was dry and very furred, and he had persistent hiccup. His blood-chloride and his alkali reserve were subnormal (Fig 399). In this case alkalis were used with caution, and he was treated by isotonic saline intravenously, his daily intake being maintained between 90 and 100 fl. oz. The patient showed satisfactory progress, and the blood-urea fell considerably. On the sixteenth day after wounding he had a severe secondary hæmorrhage which necessitated an emergency amputation above the site of fracture. His general condition was such that he was given three pints of blood. Once more he developed acidosis and was therefore given 500 c.c. of  $\frac{1}{2}$ -mol sodium lactate intravenously. His

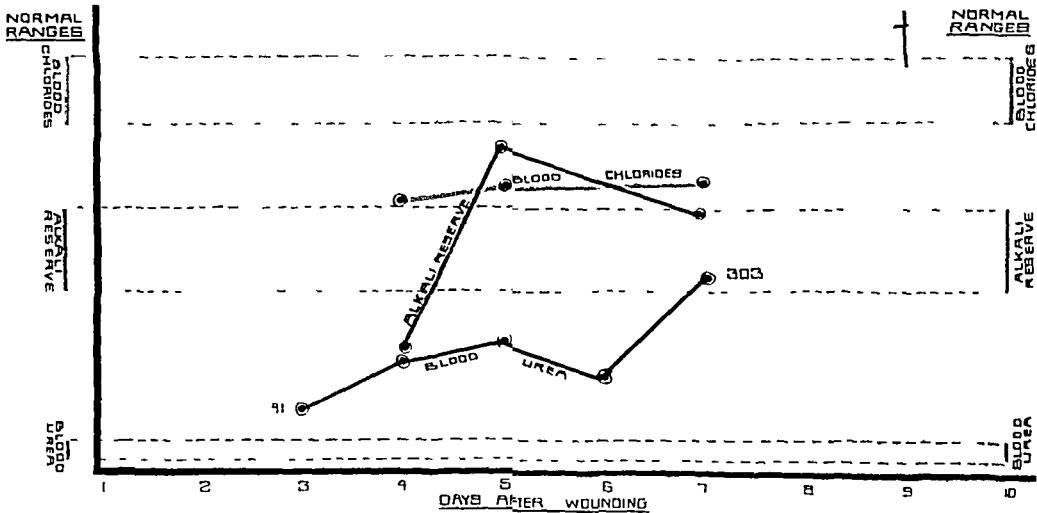


FIG 398—Shows the biochemical course of Case 9. There is a progressive rise in the blood urea. On the fourth day the blood chlorides are low and the patient is in a state of acidosis. This case illustrates the ease with which the patient can be brought from acidosis to a state of alkalosis.

intravenous sodium lactate, but the restoration of the alkali reserve was difficult to maintain. Even if the electrolyte balance of the blood is corrected early, the disease is still progressive and there is a continued rise in blood-urea (Cases 9, 10, Table I).

Case 9—Private K was admitted, under Sq/Ldrs Morel and Belcher, on the fourth day after receiving a perforating wound of his popliteal fossa. Amputation

condition deteriorated, his blood-urea rose, and he died on the nineteenth day.

It was found in other cases that the pH of the urine failed to reflect the level of alkali reserve, and it was usual for patients to secrete acid urine after the alkali reserve had been increased or while in alkalosis, even cases of a milder nature with recovery showed this phenomenon.

*Case 11*—Sapper B was admitted under the care of Wing Commander J C Scott and Sq/Ldr Vitek on the seventh day after wounding. He had received

In none of the fatal cases did the blood-chloride value return to normal levels, whereas in the biochemical investigation of severely wounded battle

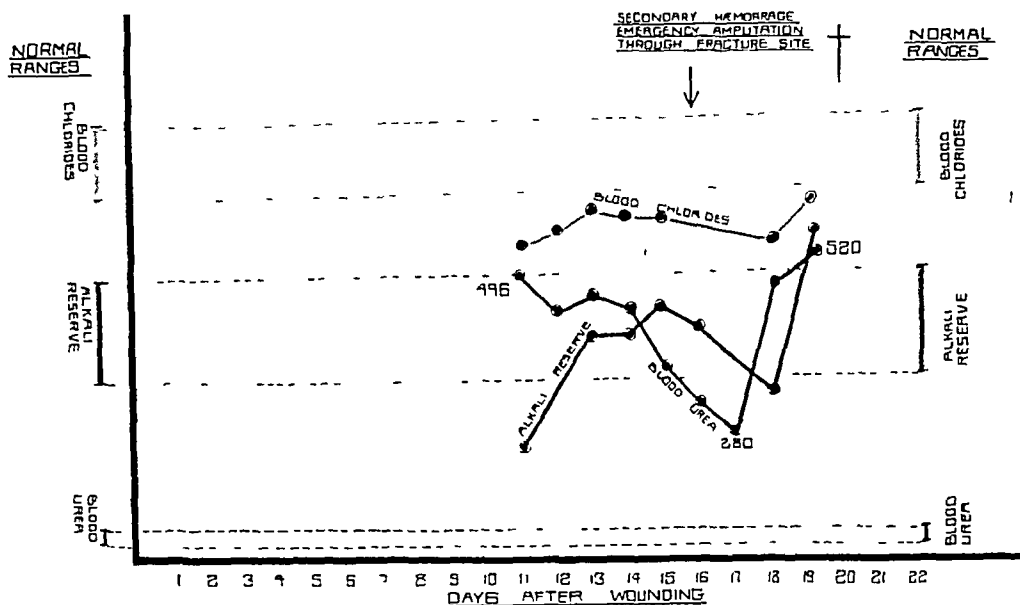


FIG 399—Biochemical course of *Case 10*. The first estimations on the eleventh day after wounding show a greatly increased blood-urea and a considerable fall in the blood-chlorides and CO-combining power. There was a temporary improvement, and following a secondary hæmorrhage the blood-urea rose. Death resulted from uræmia with alkalosis.

wounds of the left leg and buttocks in a mine explosion. Resuscitative measures had included 2 pints of blood and 3 pints of serum intravenously, debridement had been carried out and his leg placed in plaster. At the time of admission (seventh day after wounding) his condition was serious. The blood-urea was 120 mg per cent (*Fig 400*). The CO-combining power of the serum and blood-chlorides was low. He was secreting a urine of pH 5.2. He was given saline by mouth and 1 litre of 1-mol sodium lactate solution and 2 litres of glucose-saline intravenously, and on the day following his alkali reserve had risen to 68 vol, the pH of his urine being 5.4. Treatment was continued on the same lines and

casualties it was found that although initially the blood-chloride was low there was a progressive increase to within normal limits. Further, the use of alkalis was liable to cause a severe alkalosis. This would appear to be important, and will be commented upon in the discussion.

Further biochemical abnormalities were the rise in serum-potassium and inorganic phosphate, in some cases there was a fall in serum-sodium, and in the later cases serum-calcium, but the last four observations were infrequent and cannot be given in full.

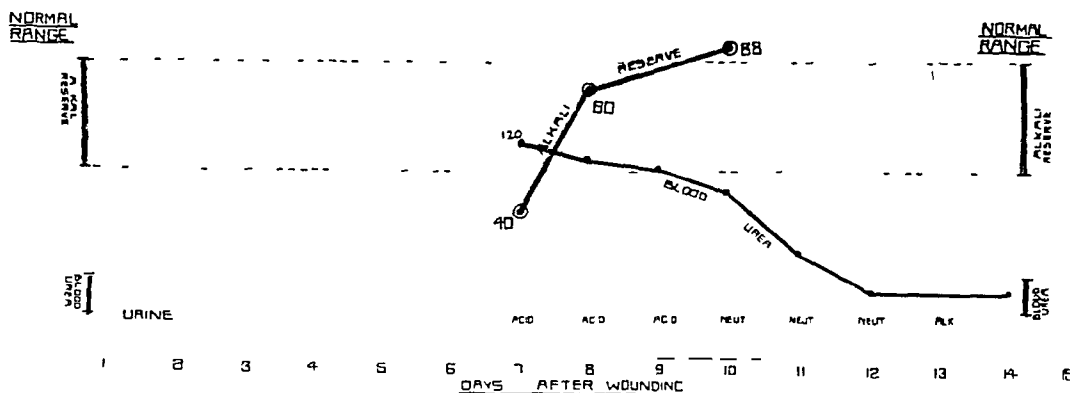


FIG 400—Shows the biochemical course of a mild case of traumatic uræmia (*Case 11*). The reaction of the urine does not reflect the changes in the level of the CO-combining power of the blood. The patient is in alkalosis on the tenth day and secretes a neutral urine. When the blood urea has returned to normal the urine becomes alkaline.

the alkali reserve rose to 88 vol, the urine still remaining acid. An improvement in his general condition was noted. His blood-urea had returned to normal limits on the twelfth day, but it was not until the thirteenth day that the urine became alkaline. He progressed to complete recovery.

## AUTOPSY FINDINGS

**Macroscopical**—The post-mortem examinations were carried out as soon as possible after death. In some cases amputation had been performed. The degree of muscle damage was slight, except in

**Case 17** The tissues and muscle groups adjacent to the wounds were carefully incised in order to assess the amount of necrosis, which was insignificant, and to exclude the presence of concealed hæmatoma. Search was made for other internal injuries.

In Cases 5, 9, 10, 15, and 17 there had been evidence of ventricular failure in life, and this was confirmed post mortem. In the majority of cases minor degrees of fat embolism were found, particularly in the lungs.

The kidneys of all cases were similar. In those dying early, the capsule stripped easily, the cut edges were everted. The demarcation was accentuated by the yellow glistening texture of the cortex. In those cases dying later, the kidneys were cyanotic, although the yellow refractile surface of the cortex was again noticeable. The capsule was wrinkled and suggested that the kidney had been under tension. No other gross lesions were found in other organs.

**Microscopical**—Microscopical examination of the liver, spleen, heart, brain, lungs, suprarenals, and kidneys were carried out in every case. The last four organs were also examined for fat. Except for Case 1, no lesions were noted in the *suprarenals*, and in this case there were small punctate hæmorrhages scattered throughout the gland. In turning to the kidney and liver, however, the close similarity of the changes to those seen by Bywaters and Dible (1942), Shaw Dunn, Gillespie, and Niven (1941), and Maegraith and Findlay (1944) was immediately noted.

The *liver* showed a central vein necrosis, and in Cases 5 and 10 there was increase of reticulin fibres and early fibrosis. The histology of the *kidneys* varied only slightly from one another. In the main, however, the changes were proportional to the length of survival. All cases had widespread necrosis of the tubular epithelium, most marked in the ascending and descending loops of Henle. Loss of nuclear staining and crenation of the tubular epithelium lying free from the basement membrane were frequently seen without definite cast formation. In later cases epithelial 'plications', concentrated in the collecting tubules, was also observed. In some, degenerate epithelium was seen lying in the lumen, whilst regeneration of the basement membrane was seen surrounding it.

Alteration in the glomeruli was minimal. Many appeared bloodless and a thin layer of eosinophilic material was arranged peripherally around Bowman's capsule. In the later cases this was not so noticeable. The first convoluted tubules showed only mild degenerative changes. There was a loss of nuclear staining and pyknosis of the muscle. Lying in the lumen of the tubule a 'catarrh' composed of albuminous material was seen. In the second convoluted tubules changes were more advanced, epithelial degeneration and cast formation being obvious.

The presence of casts was most striking in the ascending and descending limbs of Henle. The numbers varied from case to case and from area to area. The interesting feature was the obvious change in their composition (Fig 401). In those cases dying early they appeared to consist largely of hyaline material, in the later cases pigment casts

were seen more frequently. In some, pigment was seen surrounding some central focus, e.g., a fragment of degenerate epithelium or sulphanilamide crystals (see Fig 402). When stained by Masson or Mallory the casts appeared to consist of protein, but the stain

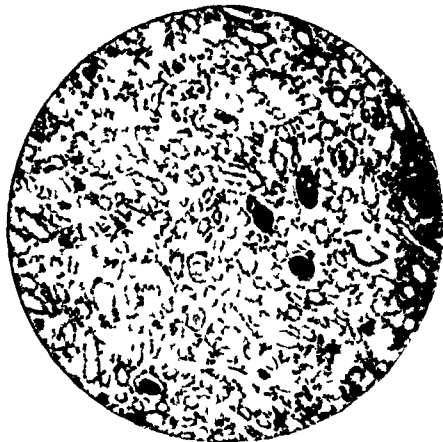


FIG 401—Section of the kidney showing degeneration of the epithelium in the ascending and descending limbs of Henle as the most marked feature of this syndrome. The wide variety of cast formation is also noticeable. H & E ( $\times 90$ )

was taken up irregularly and varied from blue to red. In places granular material was also seen, staining pink with Mallory. At the same time, stripping up of the degenerative epithelium is seen ('plications'—Bywaters and Dible, 1942), whilst the remaining

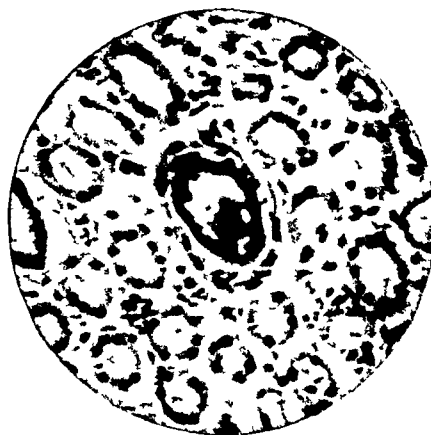


FIG 402—The formation of the cast frequently occurs around sulphanilamide crystals. There is also degeneration of the surrounding epithelium. H & E ( $\times 185$ )

casts were infiltrated with polymorphonuclear leucocytes and plasma cells. This was most marked in the collecting tubules.

All cases showed tubulovenous ruptures (Shaw Dunn, Gillespie, and Niven, 1941, Bywaters and Dible, 1942, Maegraith and Findlay, 1944). In some cases these were obvious, but in other cases were difficult to find. Serial section in areas where interstitial blood was seen led to their discovery in all cases (Fig 403). Tubular ruptures occurred

most frequently in the boundary zone, and, although usually in venous spaces, it also occurred in the interstitial tissues. In some veins, particularly in the later cases, organizing thrombi were also observed (Fig 404)



FIG 403—The absence of blood from the glomerulus and the 'catarrh' lying within the lumen of the first convoluted tubules is a feature of the syndrome. In addition two tubules about to rupture into a vein are also seen. The lower has an ante-mortem thrombus adhering to its projecting surface. Mallory ( $\times 52$ )

Serial section of these veins show that they do not necessarily occur as a result of tubulovenous ruptures.

In the interstitial tissue a patchy œdema was frequently observed in early cases. Later cases

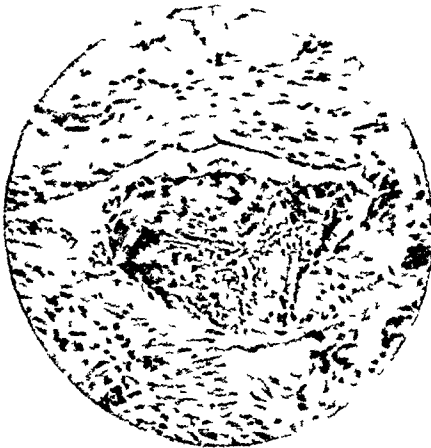


FIG 404—An organizing thrombus is seen lying within and attached to the walls of a vein. These are not necessarily associated with tubulovenous ruptures. H & E ( $\times 90$ )

showed localized groups of histiocytes, and lymphocytes, with early fibrous tissue formation. These were observed more commonly in the boundary zone, and are probably the result of tubulovenous ruptures.

## DISCUSSION

Some difficulty was experienced in assessing the part played by the disturbance of the electrolyte

balance in the production of traumatic uræmia. Acidosis has long been recognized as accompanying severe clostridial infection (Almroth Wright, 1917), but as the result of the experiences of the Staff of R A F Hospital, Wroughton, it was soon clear that hypochloræmia and acidosis were often present in cases not complicated by gas gangrene. These findings are supported by Cooke et al (1945). In these patients the response to treatment was gratifying, and, provided saline was given by mouth, in the majority of severely wounded men no other treatment was necessary. It was also noticed that in both these types of cases, in spite of the severity of their biochemical upset, kidney function was not grossly impaired. In support of this, the following case is quoted.

Sgt P developed fulminating gas myositis, with acidosis and hypochloræmia. He was aged 23, and was admitted eighteen hours after wounding, under the care of Sq/Ldr Corson. His injuries consisted of gunshot-wound compound fracture of right femur. A local debridement had been carried out soon after wounding, and he had been evacuated in a Tobruk plaster.

On admission he was extremely restless and complained of pain in his leg. During the night his condition became very much worse and it was clear that he had developed fulminating gas myositis. Emergency amputation was carried out above the fracture site, at the same time transfusion with 3 pints of blood was given, with 120,000 units of polyvalent anti-gas-gangrene serum intravenously. This was followed by 500 c.c. of  $\frac{1}{2}$ -mol sodium lactate and 1000 c.c. of isotonic saline. A full course of penicillin, 15,000 units three-hourly, was also started. After this he rapidly improved, and was evacuated to an E M S hospital on the sixteenth day.

The biochemical changes in the above case are illustrated in Fig 405, and besides stressing the gross disturbance of electrolyte balance and absence of kidney failure, bring out several other points. (1) There is an immediate alteration in the  $\text{CO}_2$ -combining power by the intravenous use of 500 c.c. of -mol sodium lactate solution, but the response to sodium chloride is slow. (2) The body conserves its stock of sodium chloride after depletion, for even after the blood-chloride has returned to the normal there is no secretion of chloride in the urine for three to four days.

It is obvious that adequate biochemical facilities are necessary before treatment of these cases can be undertaken, so that the  $\text{CO}_2$ -combining power can be observed during treatment. The fact that an acid urine may be secreted in the presence of alkalosis has been noted again and again. This is in accordance with the findings of a large number of workers, and was a feature in the salt-deficiency experiments of McCance and Widdowson (1936). Observations on the urinary pH alone may lead to over-alkalinization, and this is not without its dangers. Many writers (Cooke, 1932, McCance and Widdowson, 1937, Oakley, 1935, Cope, 1936, Nicol, 1940, Maegraith and Havard, 1944, and the Army Malarial Research Unit, 1945,) have laid stress on this point. Again, Wakeman et al (1932) and Maegraith and Findlay (1944) have shown that uræmia in blackwater fever may occur equally in acidosis or in alkalosis (and the kidney lesion in blackwater fever is essentially similar to the kidney lesions in traumatic uræmia). Bywaters (1945) suggested that the



production of an alkaline urine is an essential part of the treatment of cases of traumatic anuria following crush. In this series of cases it was found difficult or impracticable to produce an alkaline urine, and it is submitted that this method of treatment is

During the next ten days three attempts to close the duodenal fistula failed, and, in spite of intravenous and intrasternal infusion of casein hydrolysate, glucose, and saline, he developed uræmia and died, 38 days after initial injury. His blood-urea rose to 290 mg per cent the day before death.

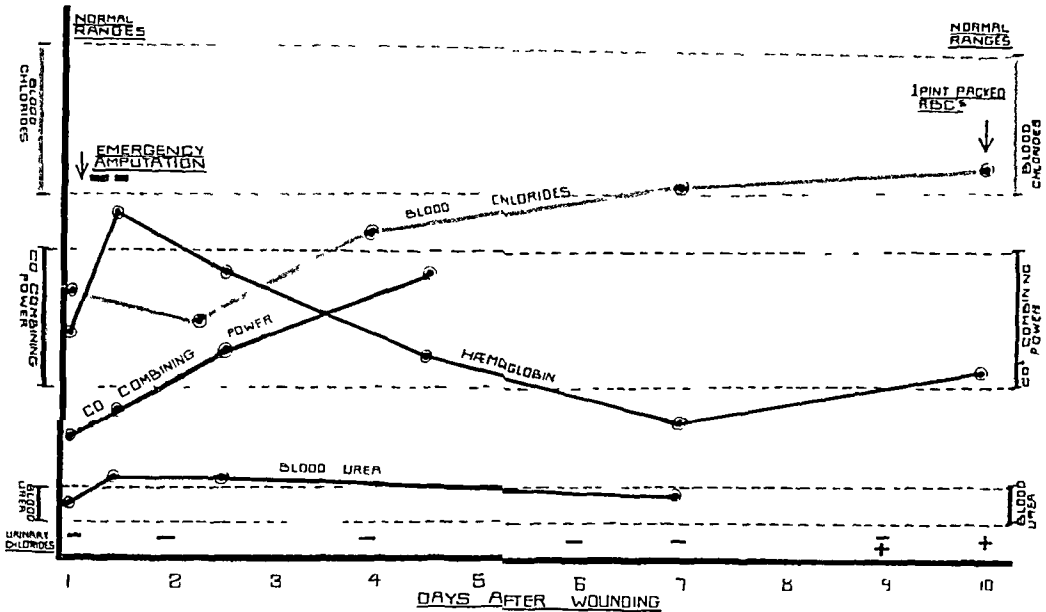


FIG. 405.—Shows the biochemical changes in a seriously wounded man. Note the initial serious reduction in serum CO<sub>2</sub> combining power and in blood-chlorides. Chlorides were not found in the urine until the blood chlorides had reached normal for three days. This case showed slight elevation of the blood-urea.

impossible to achieve. Indeed, in view of the ill effects of over-alkalinization, it is probably dangerous. The general survey of the present series and the above cases in the literature would seem to indicate that it is more important to correct the salt deficiency than the alkali reserve. But since a low alkali reserve and low blood-chlorides have been found in other wounded men, it is felt that the electrolyte balance does not, in fact, play a major part in the production of traumatic uræmia.

Turning to the discussion of other possible aetiological factors in production of this type of uræmia, it is well to decide which of the lesions observed in the kidney can be considered as truly characteristic. First, it would appear that the presence of pigment casts in the tubules is not an essential feature. Two additional cases may be referred to in evidence of this. In the first case, epithelial degeneration in the descending and ascending limbs of the loops of Henle and tubulovenous ruptures were present without any casts being found, and the patient died with a raised blood-urea.

**Case 13**—A corporal, aged 23, was wounded on Sept 23, 1944, in Northern Europe. He received a compound fracture of tibia and fibula, with a penetrating wound of his right loin. On the following day an exploratory laparotomy was performed, but, although a large retroperitoneal hæmatoma was found, no perforation of the gut was seen. Twelve days after his injury the wound broke down, discharging duodenal fluid. He was evacuated by air, and, on arrival 20 days after wounding, the wound was still discharging. His blood-urea was 91 mg per cent and serum-chlorides 303 mg per cent.

At post-mortem examination a large abscess was walled off in the duodenal area. This extended backwards into the loin. A large fistula was found in the second part of the duodenum posteriorly about  $\frac{3}{4}$  in by  $1\frac{1}{2}$  in.



FIG. 406.—Marked degeneration of the epithelium of the limbs of Henle are seen without cast formation in a case dying of duodenal fistula, with severe urea retention. H & E ( $\times 52$ ).

diameter, through which duodenal fluid escaped. The liver showed an early fatty change. The kidneys were enlarged and the cut surface presented the picture of 'traumatic uræmia'. However, on section, although epithelial degeneration of loops of Henle were noticeable, cast formation was conspicuous by its absence (Fig 406). A few tubulovascular ruptures were also found.

This should be compared with that from another case of traumatic uræmia (*Case 9, Fig 401*)

The second case died nine days after a head injury, and the blood-urea was only 56 mg per cent twenty-four hours previous to death. There were abundant casts in the tubules, but no demonstrable changes in the tubular epithelium.

Sgt R., was involved in a jeep accident, receiving a fracture of his femur and base of the skull. He was given a blood transfusion and his femur placed in a Tobruk plaster. Forty-eight hours later he was evacuated by air to Wroughton. On arrival, he was semi-conscious. Hæmoglobin was 10.5 g, hæmatocrit 31, alkali reserve 39 vol per cent. Urine showed no fat. He was treated by oral saline drip, but his condition deteriorated and he died eight days after injury, his blood-urea being 56 mg per cent one day before death.

Post-mortem examination showed a fracture of the skull extending from the left parietal bone through the petrous bone and across the body of the sphenoid, extending forward through the wing of the sphenoid on the right side. Considerable œdema and laceration of the brain was noticeable. No evidence of fat embolism

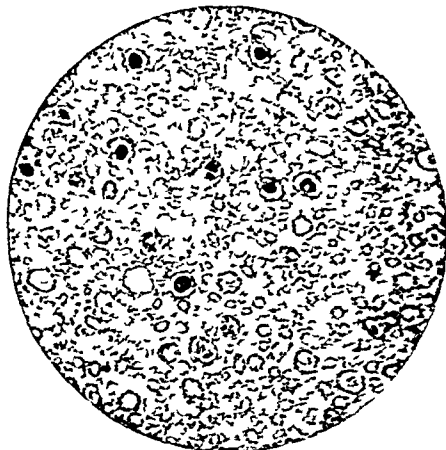


FIG 407.—Cast formation in the collecting tubules and limbs of Henle of the kidney are seen in a case dying from head injury, and without severe urea retention. H & E ( $\times 52$ )

was seen. No other abnormality of the other organs was seen except that the lungs were extremely œdematous. On section, the kidneys did not show noticeable epithelial tubular changes, although large numbers of casts were seen (*Fig 407*).

Cummings (1942) has reported similar findings.

Taking these two cases with the previously described cases of traumatic uræmia, it can be stated that pigment casts may be present without evidence of renal failure and that all cases with degeneration of the loops of Henle show evidence of renal failure. It would appear that the tubular change is the essential and characteristic lesion in these cases dying of uræmia and that the presence of pigment casts is incidental. This is in accordance with the opinion expressed by De Navasquez (1940), Bywaters and Dible (1942), Eggleton et al (1943), and Maegraith and Findlay (1944), who did not accept the original theory put forward by Barratt and Yorks (1909), Baker and Dodds (1925), and Morrison (1941) that renal failure was caused by a

blockage of the tubules by epithelial debris and casts.

The possible causes of this tubular degeneration must now be discussed. Many workers have suggested that some toxic substance acts upon the renal tubular epithelium (Minami, 1923, Bywaters and Beale, 1941, Bywaters and Dible, 1942, and Eggleton, 1944). It has been suggested that this nephrotoxic substance is derived from damaged muscle, but in this series now reported many of the cases had little muscle damage, and during the same period many wounded men with extensive muscle necrosis were examined and showed little, if any, disturbance of renal function. Experimental workers have been unable to reproduce the syndrome by the crushing of limbs (Bywaters and Popyak, 1942, Duncan and Blalock, 1942, and Eggleton et al, 1943), nor is it produced by the introduction of pigment into the circulation, unless the animal is in a state of acidosis (Bywaters and Stead, 1944, Bing, 1944). Foy et al (1943), in criticizing previous workers in this field, suggest that dehydration and the substance used to produce acidosis have an equally important role in the production of renal failure.

The views of Tombs (1942) and Maegraith, Havard, and Parsons (1945) have recently attracted attention. These authors have suggested that there are many examples of this syndrome in the literature, and that a diminution in blood-flow through the kidney is the possible factor in its production. They believe that the renal anoxia produced in this way, should it persist, would cause damage in the areas last supplied by blood, i.e., the loops of Henle, the area in which the maximal damage is found. The work of Cournard et al (1943) and Lauson et al (1944) has brought conclusive proof that vasoconstriction of renal arteries occurs in shock. When shock is produced in animals by bleeding, uræmia may develop (Meyler, 1935, Corcoran and Page, 1943, Phillips et al, 1946). Again, temporary occlusion of the renal vessels with local anoxia produces a picture comparable to traumatic uræmia (Scarff and Keele, 1943, Van Slyke et al, 1944, Badenoch and Darmady, 1947). It must be pointed out that in the present series of cases of traumatic uræmia, factors which might lead to renal vasoconstriction were invariably present (i.e., shock and damage to major vessels and limbs). Barnes and Trueta (1942) have shown that localized trauma of one leg in animals will lead to widespread arterial spasm, which might extend to vessels supplying more vital organs. Trueta (1945) has drawn attention to the fact that in shock over-stimulation of peripheral nerves may cause persistent spasm of renal and other arteries, and this would lead to interference with the blood-supply and result in renal anoxia.

There seemed, therefore, strong evidence that vasospasm was responsible. It followed that should the spasm be relieved sufficiently early the renal circulation might be restored, and the patient recover. For many years it has been realized that renal vasoconstriction can be obtained by stimulation of the splanchnic and peripheral nerves (Bernard, 1859, Bradford, 1889, Homer Smith, 1941), and that division of the nerves prevents this action.

Trueta (1944) suggested that a 'splanchnic block' might act in a similar manner in the human. The value of this manoeuvre has been shown in 'reflex anuria' (Rubritius, 1925, Havelick, 1925, Haslinger, 1927), and in incompatible blood transfusion (Hesse and Filatov, 1933, Raymond Peters, 1942). Cubitt (1936) found that a similar effect could be obtained by a high spinal anaesthetic. The effect of splanchnic block was tried in one patient (*Case 16*). This Polish private was wounded on April 25, 1945, receiving a gunshot wound of his left buttock and thigh. On the following day his leg was found to be ischaemic and the femoral artery injured. An immediate amputation was performed through the thigh. His post-operative condition was described as only fair. Five days after wounding he started to hiccup, and on the sixth day he was evacuated by air and admitted to Wroughton. He was now vomiting, and his blood-urea was found to be 500 mg per cent (*Fig 408*). His fluid intake was limited, and on the eighth day after wounding his blood-urea had risen to 820 mg per cent. Splanchnic block was then performed. His blood-pressure fell, and on the ninth day after

traumatic uraemia. It is pointed out, however, that splanchnic block cannot be successful if irreversible damage has already occurred, and, as Raymond Peters (1942) has said, "It cannot be too urgently stressed that whatever, if any, value splanchnic block may possess, it should only be considered the key for unlocking the door to subsequent judicious treatment."

Earlier in this paper reference has been made to the 'crisis' which is a feature of those cases with recovery. The theory of vasospasm and its sudden relief can satisfactorily explain their rapid improvement, and is seen to best advantage in *Case 16*. It would also account for the fact that kidney function tests performed in the convalescent stage show no residual damage.

Peters (1945) has recently suggested that intrarenal pressure is responsible for the degeneration of the tubules. He suggests that it occurs as the result of stagnation of blood, and the condition can be relieved by decapsulation of the kidneys. This seems to be a heroic measure to undertake in a patient desperately ill, particularly in view of the work of Styrons and Leadbetter (1944). These workers carried out unilateral decapsulation in a case of this syndrome, and by means of ureteric catheters demonstrated that there was no difference in function from either kidney, in either the acute or convalescent stage. It seems probable that kidney lesions are due to cutting down of the renal circulation rather than a stagnation of blood.

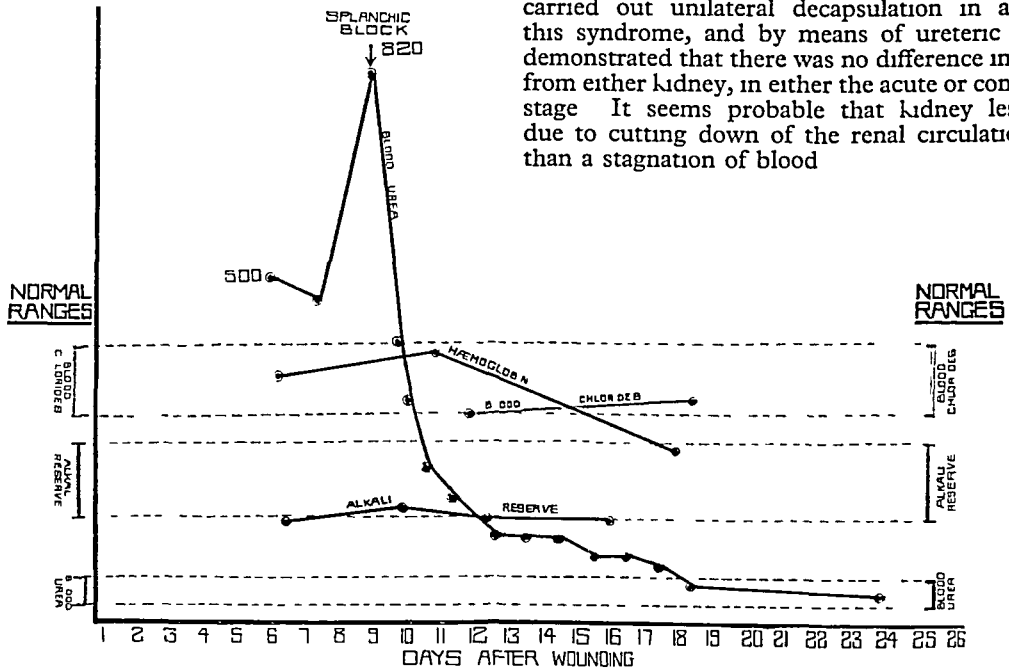


FIG 408—Shows the biochemical course of a case of traumatic uraemia with recovery. The striking response to splanchnic block suggests this treatment as a possible new line of therapy.

wounding his blood-urea had fallen to 220 mg per cent. From this day his condition rapidly improved. He was transferred twenty-seven days after wounding, his blood-urea being 40 mg per cent on discharge. A further case, *Case 17*, was treated by this method, and, although urinary secretion was re-established, death occurred from cardiac failure. The dramatic improvement seen in *Case 16* can occur spontaneously (Belsey, 1942), therefore it is unwise, at this stage, to attribute too much to the effects of the splanchnic block. Porritt et al (1945), in discussing casualties from the B.L.A., have commented unfavourably on this form of treatment for

In conclusion, there are many conditions which are followed by a similar syndrome, often terminating in fatal uraemia (Bywaters and Dible, 1942, Foy et al, 1943, Maegraith, Havard, and Parsons, 1945). This syndrome is essentially the same as that now described as occurring in battle casualties, and the same renal lesion, degenerate changes in the loops of Henle, is present in all. A satisfactory explanation of the cause has not yet been given. The most acceptable theory seems to be that of renal anoxia, which may well be brought about by vasospasm. This in its turn may be produced by various conditions such as shock, sensitizing antigens,

dehydration, and hypochloræmia. It is suggested that vasospasm is the immediate cause of the renal failure and tubular damage, and further experimental work is essential to test this hypothesis.

### SUMMARY

1 A syndrome of uræmia following the hazards of war based on 17 cases is described with special reference to biochemical and histological data.

2 The aetiological factors and the similarity to other conditions have led to the conclusion that the ultimate cause of death is renal anoxia. The mechanism of the production of renal anoxia by alteration of the blood-supply to the kidney by vasospasm is debated.

3 The dangers of over-alkalinization, and possible help through splanchnic block, are brought forward.

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I would also like to express my thanks to L A C W Donnelly and Corporal Hagger for drawing the charts, and for tabulating the many case records of this and allied conditions.

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# OSTEITIS PUBIS AFTER SUPRAPUBIC OPERATIONS ON THE BLADDER WITH A REPORT OF TEN CASES

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In the second quarter of the twentieth century endoscopic operations have more and more supplanted the suprapubic approach to the bladder. There will, however, always remain many indications for the latter method and possible complications cannot be disregarded.

Osteitis pubis is mentioned in very few of the published papers dealing with complications of suprapubic operations on the bladder. The standard text-books on urology and general surgery have practically no reference to this condition. Two exceptions are Hugh Cabot's *Modern Urology* (1936) and Lichtenberg's *Handbuch der Urologie* (1926). H. Cabot gives a very good account, while in Lichtenberg's work, F. Voelcker and H. Boeminghaus devote one short sentence to "osteomyelitis after suprapubic vesical operations".

The complication was originally described by Dr. Edwin Beer (1926) and for many years was thought to occur only after incision into the bladder. In 1933, however, Barnes reported a case after a perineal prostatectomy. Wilensky (1938) called attention to 2 cases in women: the first followed symphysiotomy during a difficult labour, and in the other a vaginal discharge which appeared after "normal" delivery was traced to a vaginal sinus leading to the pubic bone. Kleinberg (1942) reported a third case in a woman, but admits "it is difficult to judge how the pubes became infected".

It was certainly not by direct extension of an adjacent infectious process. Strictly speaking, therefore, this last case does not fit into this group of traumatic osteitis. However, he also states that "instances of typical pubic osteitis have followed a hernia operation which was infected, a prostatic abscess, and an occupational trauma to the lower abdomen".

Having recently recognized a case of osteitis pubis, I have inquired into the subsequent history of 300 cases upon which suprapubic operations on the bladder had been performed during the past three years. At the time of writing 103 patients were no longer alive and 23 were not traceable. Among the remaining 174 patients 6 cases of osteitis were verified, and, in addition to these, 3 others have been observed during the last few months. Only those cases were taken into account in which pre-operative X-ray films were still available for comparison with those taken two or three years after operation. In this series the incidence of osteitis pubis was 3 per cent, and it is clear that this serious and as yet obscure complication is by no means a rare one, and it is likely that minor degrees of the trouble are frequently overlooked.

## CASE REPORTS

Owing to the limitations of space only the positive findings are given.

**Case 1 \***—W. W., aged 62. Harris prostatectomy for a simple adenoma on Oct. 30, 1943, and discharge home on Nov. 23.

He was seen again on Dec. 22. In the meantime micturition had been free, but there was slight terminal dysuria. Since about the tenth day after discharge from hospital he had had pain in the area of the symphysis pubis, along the inner aspect of both thighs, and over both tubera ischia, preventing him from properly sitting down. On examination he was extremely tender over these areas. The adjoining muscles were all spastic.

During the following months the above symptoms got so bad that he could only with great effort sit down, get up, or move about in bed. At times he was entirely incapacitated and found relief only by complete rest in bed. In February, 1944, there was great wasting both of the glutei and of the adductors. Very slowly his symptoms subsided, but were not gone until November, 1944. An X-ray film taken in September, 1944, showed new-bone formation in the inferior ramus and irregular outlines of the medial borders of the pubic bone, with a considerable gap at the site of the symphysis (Fig. 409).

**Case 2**—A. J. Th., aged 58. On March 31, 1945, prostatectomy for a clinically benign adenoma. Convalescence delayed by right upper-lobe pneumonia. Microscopy of the prostate showed early malignant changes, but there were no further complications and patient was discharged home on April 28.

He was readmitted on May 10 because he had symptoms and signs of osteitis pubis. Digital examination also revealed a small symptomless carcinoma of the rectum which was fixed to the lower sacrum. The temperature was 100.2° F. There was occasional discharge of pus from the lower end of the suprapubic wound, but bare bone could never be felt with a probe. The symptoms gradually subsided and he was up and about again in October, 1945. Earlier in June left inguinal colostomy had been performed.

On Nov. 10, a recently formed vesical calculus had to be removed, but before proceeding with this an incision was made from the inferior pubic angle along the right ramus to the right ischial tuberosity. On cutting down to bone across parts of the adductor magnus origin about 10 c.c. of pus welled up. Specimens were taken of thickened connective tissue and rough bone and sent with the pus for pathological examination. The following cystolithotomy showed the neck of the bladder to be soundly healed and there was no evidence of any recurrent malignant changes.

The pathologist (Mr. T. H. C. Benians) reported as follows—

"1. Tissue taken from the wall of the abscess cavity lying over the inner eroded surface of the inferior pubic ramus consists of pyogenic granulation tissue and fatty tissue showing chronic inflammation and fibrosis. The granulation tissue shows some rather unusual features in the form of nodules and sheets of epithelioid cells and giant cells somewhat suggestive of a tuberculous process, although nests of polymorphs constituting small abscesses occur. It is undoubtedly a picture of a chronic pyogenic infection. A few small spicules of bone disintegrated by the microtome are present."

\* This case was shown at the Meeting of the Middlesex County Medical Society on June 9, 1945.



A



B

FIG 409—A, Before operation Normal pelvic bones B, 11 months after operation Still showing diffuse absorption, fraying at the symphysis, but also new-bone formation at both inferior rami C, 26 months after operation Advanced signs of healing (clinically symptomless)



C

"2 A fragment of spongy bone of which the periosteal surface does not appear in the sections It is composed of trabeculae of original lamellar bone and the fatty marrow shows a mild degree of chronic inflammation

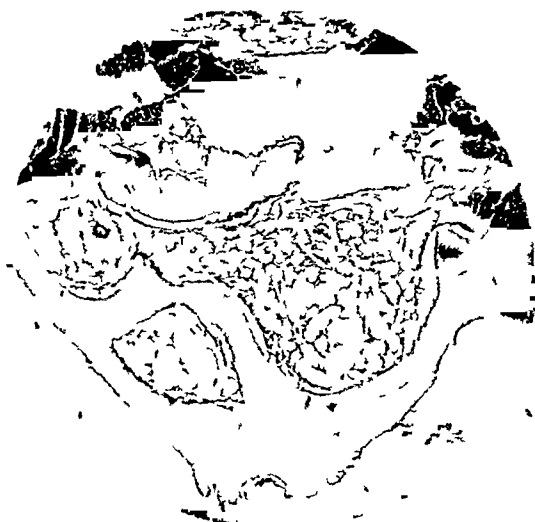
"3 5 c c of pus Films show degenerate pus, but no organisms were seen Cultures produced a scanty growth of *Ps pyocyanea*

"It is a fair assumption that the inflammation of the pubic bone and the suppuration of the adjacent soft tissues are associated processes Both are of a mild or subacute type, the organism isolated, i e, *Ps pyocyanea*, is not uncommonly found in old-standing infections of the bladder, although usually accompanied by staphylococci, and the infection is probably derived from this source Perhaps a staphylococcus has taken part in the inflammatory process and has since died out

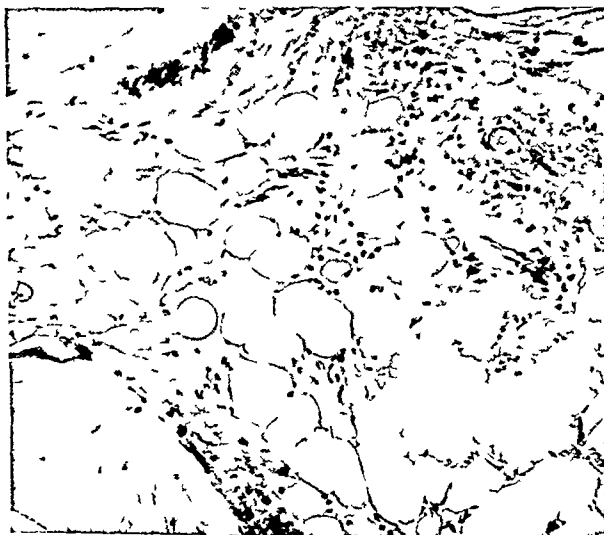
"Such low-grade infecting organisms as these might well be associated with inflammations of the chronic type described here" (Figs 410, 411)

Case 3—J H W, aged 45 Partial cystectomy for carcinoma of the bladder on June 20, 1945 Three weeks later patient was passing most of his water by the

urethra From the fourteenth post-operative day, however, the temperature was slightly raised, and from the twenty-first day he complained that movement of his pelvis caused pain over the symphysis, radiating down the inner aspect of the right thigh By August the full picture had developed, including terminal dysuria, pain on defaecation, and wasting of the adductor muscles



A



B

FIG 410—Fatty marrow with chronic inflammatory infiltration, mainly plasma cells (A,  $\times 28$ , B,  $\times 117$ )

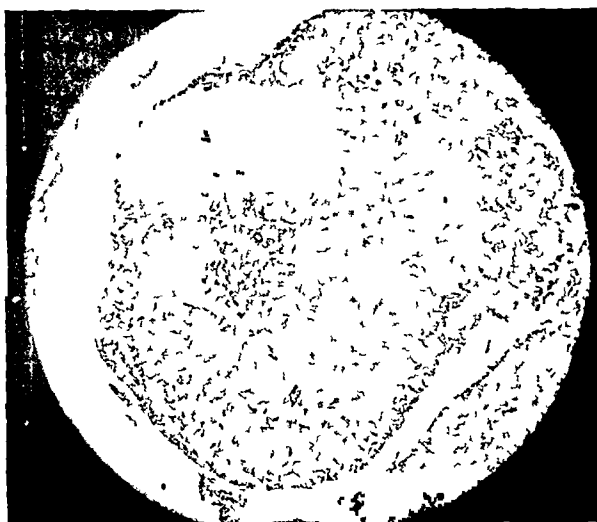
Later radiographs clearly showed periosteal new-bone formation, with eventual reappearance of normal bone. He is back at his old job since January, 1946.

**Case 4**—J F E, aged 71 March 13, 1945. One-stage prostatectomy for a benign adenoma. Discharged on March 28. He had to be readmitted for bilateral epididymitis three days later.

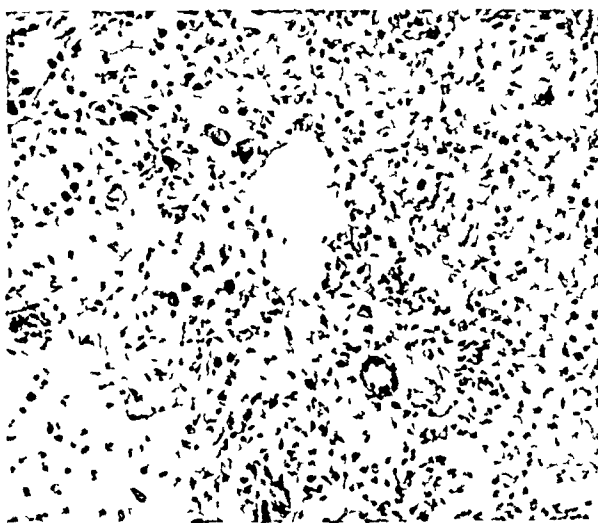
Slight fever and symptoms of osteitis appeared first on June 5. Radiographs showed small areas of absorp-

corpus pubis, with streaks of calcification across the symphysis.

**Case 9**—A Th, aged 75 June 21, 1944. Harris prostatectomy for a simple adenoma. Discharged on July 4, 1944. First symptoms four weeks later. Mid-September, 1945, he was still found to be tender over the sites in question and X-ray films showed diffuse areas of absorption at the medial portions of the pubic bodies, more obvious on the right.



A



B

FIG 411—Pyogenic membrane showing giant cell, and nests of polymorphs (A,  $\times 34$  B  $\times 117$ )

tion in the lower third of the pubic body and in the inferior ramus. New-bone formation in both inferior rami was seen in December, 1945.

**Case 5**—E A Th, aged 65 Feb 28, 1943. Suprapubic cystostomy for acute retention due to fibrosis of the bladder neck. He attended the out-patient department at intervals to have his de Pezzer catheter changed. During this time he had persistent symptoms of osteitis pubis, which were, however, not recognized then, and had again subsided by July, 1945. X-ray films taken now showed unmistakable new-bone formation over the inferior ramus and lower borders of pubic body.

**Case 6**—D P, aged 75 May 22, 1945. Suprapubic cystostomy for acute retention due to a clinically benign enlargement of the prostate. Symptoms and signs of osteitis pubis appeared first towards the end of June, 1943, but were not appreciated until radiographs taken in November, 1945, proved the case.

**Case 7**—W S J, aged 79 Aug 14, 1943. Harris prostatectomy for a simple adenoma. Pain over the symphysis, adductor origins, and over the ischial tuberosities appeared first in mid-September, 1943. Two years later, although symptomless, patient was still tender over the above-mentioned areas and X-ray films showed changes due to osteitis, particularly of the left pubis and inferior ramus.

**Case 8**—A R B, aged 68 Sept 8, 1943. Harris prostatectomy for a cystic adenoma. Apart from left epididymitis, recovery was uneventful and he was discharged home on Sept 24, 1943. A few weeks later his symptoms were thought to be due to an inflammation of the vas. In September, 1945, he was still tender over the symphysis and left superior ramus and X-ray films showed three areas of residual opacities in the left

**Case 10**—A G, aged 79 Nov 25, 1942. Freyer's prostatectomy for fibromuscular hypertrophy. He had been up and about again since the nineteenth post-operative day. From the twenty-third day, however, the temperature was slightly raised and he was complaining of pain over the symphysis and right groin.

Two years later, in the course of this follow-up, osteitis pubis was recognized and confirmed by X rays.

## CLINICAL FEATURES

The symptoms, the physical signs, and the X-ray appearances of this condition are to be found in the literature, but as they seem to have largely passed unnoticed, it may not be superfluous to repeat them here.

Three to six weeks after operation the patient complains of pain in the region of the symphysis pubis. This pain may extend towards the perineum and radiate down the inner side of one or both thighs. If the man is still in bed the slightest movement of the thighs or attempts to turn over or to sit up will cause pain, if he is up, walking is difficult or impossible. In other cases standing may be easier than sitting, the latter causing unbearable pain over the tubera ischia. Urinary symptoms are rare, but terminal dysuria occurs in cases in which the origin of the perineal muscles is involved, similarly, there may be pain on defaecation. These symptoms may actually make the patient take to his bed again, because only full rest will relieve them. After many months of illness he usually gets well, but a few cases of death from severe sepsis have been reported.

On examination, the areas mentioned are extremely tender to touch. All active and passive movements of muscles originating from that part of the pelvis involved by the osteitis are limited and very painful. These muscles are at first spastic, later, in severe cases, they may show great wasting. At times there may be some discharge of urine or pus from the lower part of the operation scar, but no pathogenic organisms are obtained in culture. This discharge, moreover, does not seem an essential part of the trouble, as it often occurs in cases showing no signs of osteitis pubis. Slight fever at the onset of symptoms is, however, a characteristic feature.

No constant picture can be drawn of the early X-ray changes. Indeed, the radiographs may at first show no change. Later the first signs of rarefaction appear at the site of most trauma. After major operations this area is usually the medial portion of the lower third of one or both corpora pubis. After minor operations, fraying appears first at the upper corners of the pubic bone and in mild cases the condition may be arrested at this stage. Most of the established cases, however, later on show a definite spread involving variable amounts of pubic bone and ischium. Very rarely the condition may extend to the hip-joint, as recently reported by Silver (1941).

The symphyseal cartilage may be absorbed, giving the appearance of separation of the symphysis, and finally bony ankylosis may result. Formation of a sequestrum is the exception rather than the rule, but areas of osteoporosis and osteosclerosis are seen later. These areas may be difficult to distinguish from metastatic growth, but reappearance of normal bone, or periosteal new-bone formation resulting in osteophytes and bony spurs, with the disappearance of symptoms, eventually dispel any doubts.

### **PATHOLOGY**

Most writers agreed that the condition was due to infection. Only Wheeler (1941) rejected this and asserted that osteitis pubis is identical with acute bone atrophy (Sudeck) rather than due to infection.

He supported his view with the results of a series of experiments, in which he failed to reproduce periostitis in rabbits after the injection of mixed cultures under the pubic periosteum\*. Though it would not be wise to attach too much importance to these animal experiments, it is agreed that in mild cases of osteitis pubis only areas of decalcification can be seen in radiographs. On the other hand, most of the cases show all those bone changes usually associated with infection. Furthermore, the symptoms in typical acute bone atrophy are never relieved by rest, and pyrexia does not occur.

Of the 10 cases reported here, only 1 was explored, partly because of individual circumstances and partly because in the literature mainly non-interference has been advocated.

\* Wheeler also mentions a case of Dr P Riaboff, which at autopsy showed "no inflammatory processes of the bone or periosteum, but definite atrophy of the cellular elements of the bone". This case was to be reported separately, up to now, however, I have not been able to find a reference to it in the *Quarterly Cumulative Index Medicus*.

The findings of pus, granulation tissue, and rough bone in this one case in which the clinical picture and radiography were almost identical with the other 9, however, seemed to prove the case.

### **PATHOGENESIS**

Various explanations have been offered, but two main factors appear to be essential in the production of the infection: (1) Leakage of infected urine into the retropubic space, (2) Trauma both during and after operation.

It is asserted by many urologists that leakage into the retropubic space is, or at least has been, unavoidable. Regarding the second factor, Beer (1928) has suggested that "the infection develops in the periosteum as a result of injury to the periosteum, by traction on the attached rectus muscle". Injury by direct instrumentation, by local anaesthesia, or by pressure of the drainage tube against the underlying tissues, has also been blamed. But it has also been suggested that in other types of cases the infection travels by direct extension to the pubes. Wilensky (1938) says "the bone is secondarily bared and infected, after the separation from it of the necrotic tissue. Infection in the osseous tissue is aided by injury to the periosteum".

It is, however, against all surgical conceptions to assume that an infection, particularly a low-grade one that spreads by extension, should do so across fascial planes, instead of along them, unless first of all this path has been laid open.

It is the purpose of this paper to show that trauma inherent in the classical suprapubic approach is the main cause of osteitis pubis, as this approach involves operating as near as possible to the pubic bone.

When dividing the consecutive layers of the abdominal wall, the retromuscular space and the space of Retzius are deliberately opened (Trauma No 1).

In the following steps of the operation, retraction may cause avulsion of fibres of the rectus muscle, or the two layers of the transversalis fascia from the pubic bone (Trauma No 2).

For suprapubic prostatectomy in particular (and similarly in other operations on the bladder) the enucleation of the glandular tissue more often than not involves anything but gentle handling. Though in most cases two fingers in the rectum may sufficiently immobilize the prostate bed, very often, in my opinion, rupture of the puboprostatic ligaments is inevitable (Trauma No 3).

The early symptoms and X-ray findings seem to support the three traumata mentioned.

The factor of infection is obviously essential, but, unless the aforementioned fascial spaces are primarily traumatized and the bone bared from its coverings, it is difficult to see why infection of the pubic bone should occur rather than propagation of the inflammatory process along the fascial planes. Suppuration in these perivesical spaces has been frequently observed after endoscopic operations, but osteitis pubis has never been reported.

The only argument in favour of a process which spreads slowly to the periosteum is the long interval between operation and onset of symptoms. This long interval, however, is only apparent, inasmuch



as the early slight symptoms are naturally put down to unavoidable post-operative pain. Only later, after fully established involvement of the adjacent tissues (origin of muscles), will the symptoms become manifest.

Severe sepsis, toxic nephritis, and anuria during the immediate post-operative period are admittedly rare complications. It would, however, be interesting to know how many of these unfortunate complications could have been avoided if the prostatic plexus had not been injured and infected at operation, and also how many cases would have developed osteitis pubis had they not succumbed to the more severe infection.

It would seem that the opening of the retro-muscular space and of the space of Retzius can be eliminated if a technique slightly modified from that recently described by Dodson (1944) were adopted. According to this, the separation of the recti and pyramidalis muscles is carried out in the usual manner. Then, about 3 cm above the level of the symphysis a 2-in. long transverse incision is made through the anterior and posterior layer of the (continuation of the) transversalis fascia, prevesical fat, and vesical layer of the pelvic fascia. The lower flap is then dissected downwards off the anterior bladder wall for about 4 cm and approximated with two or three interrupted sutures to muscle at the lower angle of the wound. The two spaces are thereby securely shut off.

In a certain number of cases, as already admitted, it may be impossible not to injure the puboprostatic ligaments. In most cases, however, it should be avoidable, particularly if this complication is kept in mind.

### SUMMARY

Osteitis pubis, after suprapubic operations on the bladder, appears to be a clinical entity. After

300 such operations 10 cases have been discovered and are reported here. Symptoms, physical signs, and X-ray findings are described and the aetiology discussed, emphasizing the factor of operative trauma in the operation as currently practised. A method of operation to minimize this factor is suggested.

I am indebted to Mr Ivor Lewis for permission to publish this paper, and I wish to express my gratitude to him and Mr F J F Barrington, who read the manuscript, and Mr T H C Benians for their invaluable suggestions.

My thanks are also due to Mr E V Willmott, A R P S, for preparing the radiographs and microphotographs.

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## RAZOR BLADE IN ŒSOPHAGUS TRANSTHORACIC REMOVAL

BY T HOLMES SELLORS, LONDON

THE majority of foreign bodies that are swallowed by children produce little ill effect, but occasionally an awkwardly shaped object becomes lodged in the œsophagus. Endoscopic removal of the latter is successful in most instances and more drastic surgical measures are thereby avoided. When, however, the foreign body is so placed that it cannot be dealt with by œsophagoscopy, recourse to open operation may have to be considered. The fear of a fatal mediastinitis is present in every case of œsophageal ulceration and perforation and has relegated œsophagotomy into the category of dangerous operations.

The swallowing of a safety-razor blade by a small child is the subject of this case report. The blade became lodged in the œsophagus at the level of the aortic arch without producing many symptoms. Its discovery was more or less accidental and endoscopy showed it deeply embedded in œsophageal mucosa and unsuitable for removal by that method.

Removal was effected by a transpleural approach to the œsophagus, which was incised. The blade was removed and the œsophagus sutured. Pleural infection developed, but this was treated and complete recovery resulted.

### CASE REPORT

Male child, born September, 1942

First attended Queen Elizabeth Hospital for Children under the care of Dr Helen Mackay in March, 1945, with a history of occasional pyrexia and no gain in weight for about ten months. During the last six months he had frequently swallowed "buttons, small balls, and wheels from toys", etc.

In October, 1945, the boy was again brought to out-patients with a vague history of feverish attacks and abdominal discomfort. Further interrogation showed that he had had some difficulty in swallowing solids.

He was admitted to hospital on Oct 23, where the following investigations were made. Urine normal, W B C's 25,600 (polymorphonuclears 50 per cent,

lymphocytes 40 per cent), rectal swab *B aertrycke* isolated. The child was feverish on one occasion, but was on an ordinary diet.

Routine X-ray examination on Oct 25, showed razor blade in the oesophagus (Figs 412, 413). On further questioning, the father gave a history of the boy's inability to swallow fluids twelve days previously. In hospital the ward sister stated that he ate an ordinary dinner slowly with no evidence of pain.

Oct 25, Oesophagoscopy by Mr Ben Cohen (Anaesthesia intratracheal gas-oxygen-ether). At mid-thoracic level the lumen was occluded by swollen congested mucosa. With the application of cocaine 10 per cent, and adrenaline 1:1000, the upper end of the blade could be determined lying posteriorly and fairly well wedged in. A little pus and a few tags of macerated paper were

pus and this was attempted over the course of 12 days on fourteen occasions. Finally, it was decided to explore the chest deliberately to exclude the possibility of a para-oesophageal abscess.

Under anaesthesia two further aspiration attempts were made with negative results. A small length of rib was resected and an extensive empyema opened. The pus was extremely viscid and mucoid, as would be found in cases in which the empyema communicated with a mucous surface (such as a bronchus). This accounted for the failure of aspiration, though wide-bore needles were used in the later attempts. Ordinary drainage was established and the lung steadily re-expanded with complete healing 18 weeks after the original operation. At no time was there any evidence of free communication between oesophagus and pleura as judged by

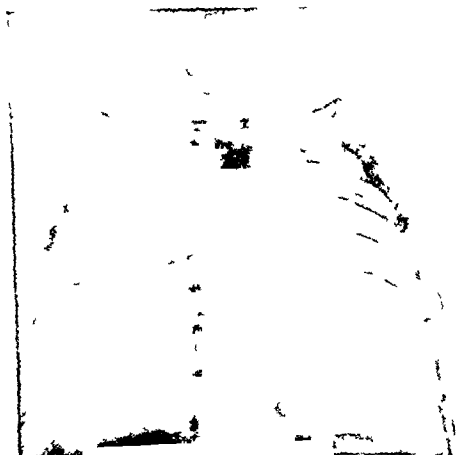


FIG 412—Anteroposterior radiograph of chest, showing razor blade in oesophagus



FIG 413—Lateral view of chest

removed. It was impossible sufficiently to shrink the mucosa to obtain a more adequate view of the rest of the blade.

Under the circumstances manoeuvres such as removal in two parts after bisection along its length or removal after fragmentation, were abandoned as impractical procedures.

The child was transferred to the Thoracic Surgical Unit at Harefield on Oct 26. Oesophagotomy was the only method for removal and a transpleural approach was decided on. Extrapleural methods of approach in a child of this size were considered impracticable.

OPERATION (Oct 26)—Anaesthesia (Dr Parry Brown) intratracheal gas-oxygen and cyclopropane. Right thoracotomy with posterolateral removal of 4th rib. The oesophagus was identified and a mass felt in it at the level of, and just above, the azygos vein. The oesophageal wall was indurated and oedematous and the surrounding mediastinal structures were adherent. There was, however, no pus. The oesophagus was incised longitudinally and the razor blade withdrawn. The eye-holes and angled edges were entangled in mucosa, through which the foreign body had heavily ulcerated. The area was dusted with penicillin-sulphathiazole powder and the incision closed with two layers of fine thread (four interrupted sutures in each). The mediastinal pleura was left open and after further application of penicillin the chest was closed without drainage in the ordinary manner with the lung re-expanded.

PROGRESS—The early convalescence was satisfactory and liquids and later soft solids were administered freely. Systemic penicillin, 2,435,000 units, was given over 25 days, as well as penicillin lozenges to suck, but about the seventeenth day fever and signs of toxæmia became apparent. Routine aspiration of the chest revealed no

swallowed food and dyes, though the character of the pus indicated that primary healing of the oesophageal wall had not occurred.

The child has remained perfectly fit and has gained weight. There has been no difficulty in swallowing since the operation, though the remote possibility of a later stricture must be borne in mind.

Comment—The razor blade when removed was partly covered in wrapping paper which may have prevented the condition from being worse than it was and have saved the mouth and pharynx from laceration when swallowing this object. Most of the paper had been dissolved by the time of operation and it was clear that oesophagotomy was the only possible method of removal. Any attempt to shift or break up the razor blade through the oesophagoscope might easily have resulted in incision of the aortic arch or azygos vein, the possibility of this was only too obvious at operation.

## DISCUSSION

The case history is given in some detail since the discovery of the razor blade was 'accidental' in that its presence was only recognized by routine radiography, otherwise the presence of *B aertrycke* in the stools might have been regarded as adequate reason for the fever and malaise which was the original cause of his attendance. Transpleural oesophagotomy is a method of dealing with impacted foreign bodies in the thoracic oesophagus and is liable to severe complications, but with the use of penicillin and adequate drainage of the mediastinal tissues (into the pleural cavity) infection should be capable of control.

# CHORIONCARCINOMA OF THE TESTIS WITH GYNÆCOMASTIA

## REPORT OF A CASE WITH EARLY BREAST CANCER

By ALEXANDER LYALL, GREENOCK

GYNÆCOMASTIA, or abnormal enlargement of the male breast, may be found in association with testicular tumours, atrophy of the testis, and certain tumours of the adrenal cortex. There is also a group of cases where no apparent cause for the enlargement can be found.

The following is the report of a case which was associated with a chorionepithelioma of the testis.

### CASE REPORT

**HISTORY**—G B, aged 24, soldier, was admitted to hospital from overseas with the history that he had had his left testis removed two and a half months previously for a tumour. He had made a good recovery from the



FIG 414—Kidney with secondary chorioncarcinoma

actual operation, but for a few weeks previous to his admission he had been losing weight and had noticed that his breasts were becoming tight and swollen.

**ON EXAMINATION**—There was evidence of recent loss of weight. Both breasts were enlarged to about the size of the normal average virginal breast. The breast substance had a firm, slightly nodular consistence and a small amount of clear fluid was expressed from the nipple on pressure. The organs were slightly tender on palpation and the nipples and areolæ showed brown pigmentation. The left testis was absent and the scar was soundly healed. An X-ray examination of the chest showed the presence of multiple, small, secondary tumours. A Zondek-Aschheim test was carried out with the patient's urine and gave a strongly positive reaction.

The condition of the patient rapidly deteriorated, secondary tumours appeared in the abdomen, and he died five weeks after admission.

**POST-MORTEM EXAMINATION**—The body showed advanced emaciation. Both lungs were riddled with secondary tumours, most of them being small, but the largest reaching a diameter of 4 cm. Necrosis and massive hæmorrhage were present in the larger ones, and in the basal region of the right lung there was a soft mass the size of a large orange which was composed of blood-clot with a nodule of white tumour at one side. The

mediastinal glands were massively involved with tumour, forming a large mass pushing the heart forward. Multiple small secondaries were present in the liver, many of them showing the usual necrosis and hæmorrhage. In the right kidney there was a nodule measuring 3 cm in diameter and bulging from the surface of the organ under the capsule. Much hæmorrhage had occurred into it (Fig 414). Secondary deposits of tumour were found in the para-aortic glands. Section into the breast tissue showed it to be firm and nodular and to have a diffuse white colour. No obvious cystic changes were apparent. There was no fatty tissue present. Permission to examine the head was withheld, so that the pituitary gland was not examined.

**Histology**—Tumours of the lungs, liver, kidney, and para-aortic glands were sectioned and examined by various staining methods. Various sections from both breasts were also examined. The tumour had the typical histology of chorioncarcinoma. The Langhans cells were cuboidal or polyhedral in shape, with clear cytoplasm which took on a slightly basophilic hue, and with nuclei which were vesicular but hyperchromatic in places. The syncytial elements consisted of irregular masses of acidophilic protoplasm containing oval nuclei of various sizes, with a dense irregular chromatin network. The two constituents were intimately mingled in many areas (Figs 415, 416). Many areas of necrosis and hæmorrhage were seen, this being particularly marked in the lungs.

Sections of the breast tissue showed that the organ was packed with ducts and acini separated by fibrous stroma. The ducts were lined with columnar epithelium, the nuclei of which were elongated and colloid. Most of the ducts were dilated to some extent and contained an acidophilic, homogeneous material in which colostrum cells and fat globules were apparent (Fig 417). Around each duct and acinus there was an "accommodative space" of loose fibrous stroma, the connective tissue outside this being dense and darkly stained. At places anaplastic changes were noted in the epithelium and there was a tendency towards spraying out of the cells into the surrounding stroma. At one point this anaplasia had advanced to the stage of definite malignancy. The ductule and acinus were infiltrated and replaced by a solid mass of cells which showed much variation both in size and shape (Fig 418). The nuclei tended to be oval and colloid, with irregular chromatin content, and mitotic figures were abundant, representing every stage of cell division (Fig 419). Giant cells with irregular, dark nuclei were seen at places (Fig 420). The tumour bore no histological resemblance to the chorioncarcinoma, and had obviously arisen from breast tissue.

### DISCUSSION

This case raises two interesting problems—

**I Cause of the Gynæcomastia**—Gynæcomastia in testicular tumours has been noted by Heidrich et al (1930), Le Sas (1931), Bergeret et al (1937), Entwistle and Hepp (1935), and Gordon-Taylor and Till (1938). Kriss (1930, 1931) pointed out that the condition arose in only 5.7 per cent of all cases of testicular chorioncarcinoma. Moreover, there is still doubt as to why it should occur at all, Gordon-Taylor (1938) adding, "Opinion is not yet finally settled as to the hormonal origin of these changes, Bruno Kriss affirming that if a

hormonal cause were solely responsible, a higher percentage of chorionepithelioma of the testicle would show it."

the one which forms the basis of the Zondek-Aschheim test, the gonadotrophic or anterior pituitary-like hormone. As this hormone is excreted

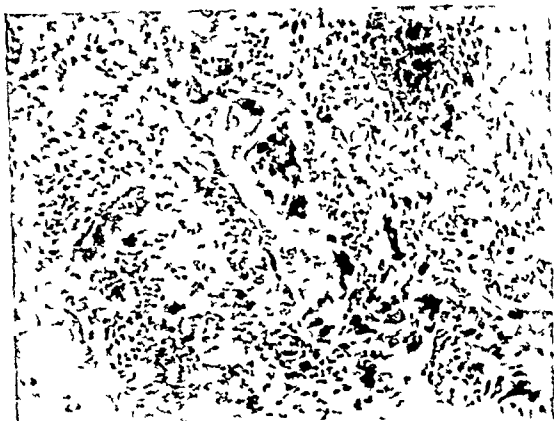


FIG 415—Low-power microphotograph showing the two component tissues of the choriocarcinoma. Areas of necrosis are also seen.

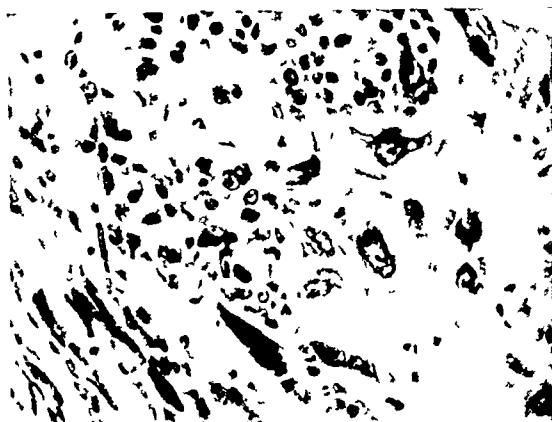


FIG 416—High-power view of choriocarcinoma showing the mingled syncytium and Langhans cells.



FIG 417—Low-power view of breast, showing a dilated duct containing homogeneous secretion and colostrum corpuscles. Many acini are also seen.



FIG 418—Low-power microphotograph, showing a mass of carcinomatous tissue growing from a duct.

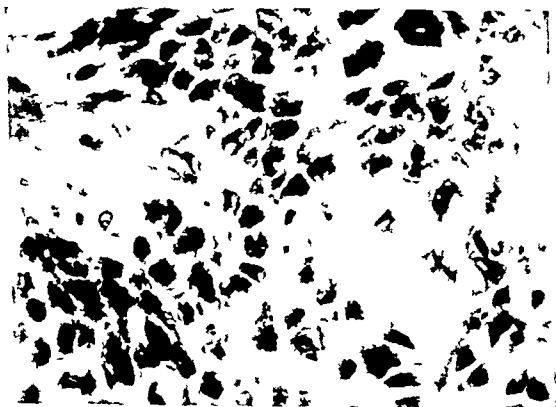


FIG 419—High-power section of breast tumour. Many mitotic figures are seen.



FIG 420—High-power view of breast tumour, showing large hyperchromatic nuclei.

In considering the problem it is natural to look to the parent tissue of the tumour for the responsible hormone. According to Novak (1941) the placenta produces three hormones. The best known is

in large amounts in many cases of testicular teratomata which show no evidence of breast changes, it is unlikely to be the one for which we are searching.

Progesterone and oestrogen are also produced in the placenta during certain stages of pregnancy. The effect of prolonged injections of oestrogenic substances in experimental animals is well known. Lacassagne (1932, 1936, 1938) did his work on mice, Geschikter et al (1934) worked on monkeys, and Burrows (1935) on mice. The hyperplasia in these experiments appeared to have involved mainly the ductal system, suggesting that another factor is necessary to give the associated acinar changes of true gynecomastia. The physiologists have suggested that whereas oestrogen plays the important role in building up the ductal system, it is the progesterone which develops the secretory acinar portion. That the pituitary may play an important part by means of some intermediate secretion is suggested by the work of Gomez and Turner (1937), who showed that neither oestrogen will stimulate breast growth in hypophysectomized rats. In their case of gynecomastia Entwistle and Hepp (1935) noted a preponderance of the clear chromophobe cells usually associated with pregnancy. Bergeret et al (1937) also described changes in the pituitary like those of pregnancy in their case.

**2 Secondary Malignant Degeneration in the Breast**—Lacassagne (1938) succeeded in carrying the oestrogenic hyperplasia of the breasts in his male animal experiments on to the stage of frank carcinoma. In discussing their cases of stilboestrol gynecomastia in the human subject, Scarff and Smith (1942) mention the presence of dangerous epithelial hyperplasia in the ducts, but there was no actual malignancy. Our case would appear to be

the first in which a true gynecomastia in the human subject due to hormonal influence has progressed to the stage of malignant degeneration.

### SUMMARY

A case of gynecomastia due to secondary chorion-carcinoma is described. The most interesting feature of the case is the presence of early carcinoma in the hyperplastic breast.

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## THE ARNOLD-CHIARI MALFORMATION

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It is common knowledge that hydrocephalus is frequently encountered in association with, or following operation for, meningocele and meningo-myelocele. What is not generally realized is that the malformation described originally by Arnold in 1894 and by Chiari a year later, which consists essentially of herniation of the hind-brain through the foramen magnum, is a common finding in these cases and that its recognition gives the clue to the correct line of treatment when the absence of associated congenital deformities offers a reasonable prospect of useful survival.

The development of thought with regard to these lesions is fascinating in the extreme. Morgagni (1769) advanced the thesis that the hydrocephalus, by reason of increased cerebrospinal pressure, was the primary cause of the meningeal bulge, but the frequent occurrence of meningocele without concomitant hydrocephalus did not fit in with this conception. Solovtsoff (1901) and Gredig and Schwalbe (1907), who christened the condition with its present name, followed Arnold and Chiari in publishing further anatomical observations. The nature of the malformation was more fully illustrated by the first British contribution to the subject, that of Russell and Donald (1935). They noted

their findings in 10 post-mortem examinations and described a tongue of cerebellum and medulla, complete with choroid plexuses and enclosing an elongated fourth ventricle, protruding downwards through the foramen magnum and lying on the posterior surface of the spinal cord. The cervical nerve-roots pursued a course upwards instead of downwards to their foramina of exit, showing that the whole cord was displaced caudally, and a variety of associated abnormalities was encountered, such as hypoplasia of the medulla, non-differentiation of the cerebellum into vermis and lateral lobes, and closure of the aqueduct of Sylvius and foramina of Magendie and Luschka. They showed by injections of Indian ink that the cerebello-medullary hernia might obstruct the subarachnoid circulation of cerebrospinal fluid or block the fourth ventricle in addition, producing a communicating or non-communicating hydrocephalus accordingly. Dandy and Blackfan (1934) had already shown that three-quarters of the cerebrospinal fluid is absorbed in the skull and only one-quarter in the spinal canal. Penfield and Coburn (1938) suggested that the plug was a traction-cone due to the fact that the spinal cord became tethered in the region of the spinal bifida and did not rise in the canal as the baby grew

and that the plugging effect was similar to that produced by the pressure-cone caused by a rise in intracranial pressure, the only difference being that in the first case the '*vis*' was '*a fronte*' and in the second '*a tergo*'.

Ingraham and Scott (1945), in a masterly series of articles, have recounted their experiences in a group of 462 patients with spina bifida, 98 of whom had meningoceles and 279 meningoceleles, the differentiation depending on whether nerve elements were or were not visible in the sac and on the presence or absence of neurological changes—weakness, sensory impairment, or sphincter disturbances. They recorded their findings in 20 autopsies, all exhibiting the Arnold-Chiari malformation, and their conclusions were similar to those of Russell and Donald, but in addition they described the co-existence of plastic meningeal exudate, microgyria (small 'wormy' cerebral gyri, more numerous than normal) and craniolacuna or *Luckenschadel* (diffuse rounded defects in the skull separated by bony ridges). The latter condition has been described by Vogt and Wyatt (1941) as frequently demonstrable radiologically in conjunction with meningocele and meningocele, particularly the former. Microgyria and craniolacuna occurred in a high percentage of Ingraham and Scott's cases, but this is not surprising considering that most of them had meningoceleles. Jefferson (1942) operated on an adult patient with symptoms of high cervical tumour and discovered an Arnold-Chiari malformation, he then had the spine X-rayed and found a sacral spina bifida. This probably accounts for the cases reported by Aring (1938) and McConnell and Parker (1938), where the Arnold-Chiari malformation alone was found, but no mention was made of excluding the coexistence of spina bifida occulta.

The practical application of these considerations, which concerns primarily the general practitioner, the obstetrician, and the general surgeon, is the question, "Is it worth while operating on a meningocele?" There are probably no two opinions on the unwisdom of operating on a meningocele, and the selection of cases is obviously limited to those unassociated with irremediable deformities or gross neurological changes (in a very young infant the latter boils down to whether it kicks its legs properly, its skin is relatively insensitive, and it has not yet developed a social conscience with regard to its sphincters), and the absence of coexisting hydrocephalus. It would appear reasonable to suppose that the cord is less likely to be tethered by a meningocele than by a meningocele, and of Ingraham and Scott's 462 cases 60, or 13 per cent, are now considered normal and another 13 per cent are suffering from mild neurological disability. And if such a reasonable percentage of affected children will lead useful lives, and if of those who develop hydrocephalus a large proportion manifest the Arnold-Chiari malformation which is amenable to surgery, more of these cases will be considered to be worth operating on.

The operative procedure is obvious—decompression of the herniated hind-brain by removal of the posterior part of the bony canal in which it is incarcerated, this is a very simple proceeding, and according to Jefferson can be performed at almost

any age. The operation is performed through a vertical midline incision, the lower part of the occipital bone, the posterior part of the foramen magnum, and the posterior arches of the cervical vertebrae are removed to below the level of the lower edge of the medulla and the dura is widely opened. The muscles and skin are closed in layers in the usual fashion.

When considering the age at which operation should be undertaken it must be borne in mind that some meningoceles are obviously in danger of immediate rupture of their thin covering membrane

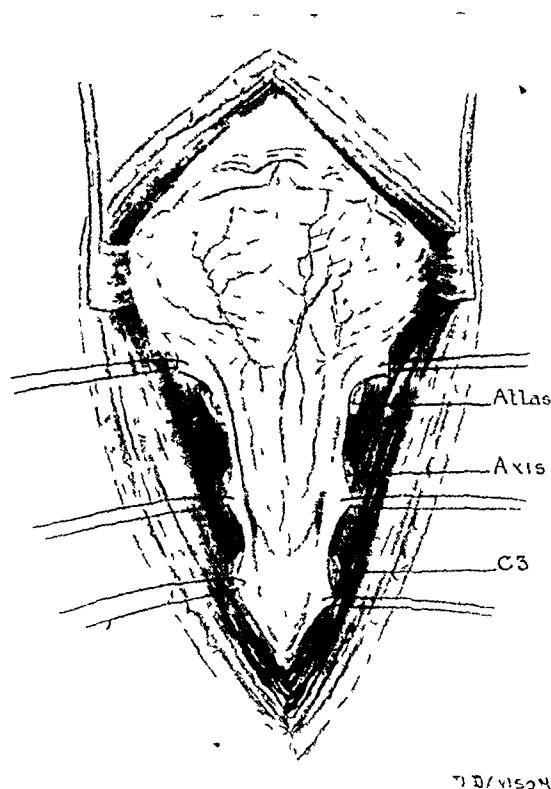


FIG 421—The Arnold-Chiari malformation

and will have to be operated on shortly after birth, but if there is no urgency of this sort it would appear that the choice lies between operating on the meningocele as soon as is reasonable and hoping that hydrocephalus will not develop, or performing decompression if, and as soon as, it does (by which time the brain may already have suffered irreparable damage), or doing a routine decompression soon after the cure of the meningocele on the grounds that a high percentage of cases are associated with the Arnold-Chiari malformation. Ingraham's opinion is that the majority should be left till the age of 12 to 18 months to permit better assessment of neurological disabilities and hydrocephalus, and that the decompression should be performed 10–14 days after the meningocele operation.

The following case illustrates many of the above points.

A female child was born with a meningocele, the covering of which was so thin as to be liable to immediate rupture. It moved its legs well, and the parents, who

were fully informed of the likelihood of associated abnormalities, were most anxious to have the child's life preserved. The meningocele was therefore excised without anaesthesia when the baby was 5 hours old, no neural elements were observed in the wall of the sac, but the gap was so large that skin-flaps extending on to the buttocks and up over the shoulders had to be utilized to cover it. A cerebrospinal fistula appeared at the junction of the flaps, but dried up in a fortnight, when the child was discharged in perfect health. Four months later it began to show signs of hydrocephalus, the circumference of the head increased from 18½ in. at the age of 7 months to 19½ in. at 13 months and 20½ in. at 16 months, the corresponding average measurements in normal girl children being 17 in., 17½ in., and 18 in., with a variation of half an inch either way (Tredgold, 1937). The child appeared listless and took no interest in its surroundings. It was then sent by its doctor to a neurological hospital whence it returned with an offer to cauterize its choroid plexuses, this was refused. In the meantime I had been informed (Jefferson) of the existence of the Arnold-Chiari malformation; I thereupon performed a cerebello-medullary decompression and found a perfect example of the condition (Fig 421). The bone, being soft, was very easy to remove, and on opening the dura the herniated cerebellum and flattened medulla were seen to extend on the posterior surface of the cord as far downwards as the posterior arch of the third cervical vertebra, which was included in the decompression. No exudate or adhesions were seen in the subarachnoid space, it was not, of course, possible to ascertain the condition of the cerebral gyri, but there was no radiological evidence of craniolacuna. Suture of the upper part of the wound in layers was difficult on account of the absence of layers and cerebrospinal fistula appeared here. The child became drowsy and irritable a week after operation and its condition gave rise to considerable anxiety, but the fistula closed spontaneously and the child was again discharged.

The head measurements have reverted to a normal rate of increase, and the parents are delighted. They say that the child at 6 months after operation is much brighter and more interested in its surroundings and is beginning to talk, and clinical observation confirms this favourable impression. It will be some considerable time, however, before it is possible to assess the extent

of the cerebral recovery, my only regret is that I was not aware earlier of the existence of the syndrome, so that the development of hydrocephalus could have been arrested or prevented before the brain became distended. The child has in addition a mild degree of congenital dislocation of one hip which hinders its attempts at walking, but which should respond readily to treatment, and slight impairment of circulation in the same leg, which is already improving spontaneously.

**Comment**—The advice given to many parents in the past has been that in view of the gloomy outlook it would be advisable to give up and start another pregnancy, or if the meningocele has been operated upon the end-results have often been deplorable, but with a judicious selection of cases there appears to be no reason for the continuation of an attitude of undue despondency.

I am most indebted to Professor Jefferson for educating me in this particular aspect of neurosurgery, and for his continued guidance in the management of the case.

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## THE TRANSFORMATION OF AN EMBRYONIC LIPOMA TO A COMMON LIPOMA

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ALTERATION of the histology of a tumour is usually either towards a more malignant form or of a degenerative nature. The tumour described here adopted the opposite course, and finally an innocent tumour was removed with every hope of a permanent cure, when the earlier histology had suggested that the prognosis might be unfavourable.

The case history and pathology are described, and there is a brief discussion on the site of origin of the tumour and the reasons for its transformation.

### CASE REPORT

**HISTORY**—The patient, F. C., female, was first seen as an out-patient on Feb. 19, 1943, when she was five months old. The history was of a swelling in the right axilla, which had been first noticed by an intelligent

mother two days previously, slight swelling of the right arm, and prominence of the right pectoral veins. No pain seemed to be present, but the mother noticed that the baby seemed to use the right arm less than the left. Otherwise the baby was perfectly well. The baby was well developed and healthy. The right arm showed slight non-pitting oedema from the axilla to the wrist and the pectoral veins were prominent. There was a moderately tense, round swelling visible in the axilla over which normal skin moved freely. There was no translucency and only doubtful fluctuation in the tumour and no swelling could be felt in the posterior triangle of the neck. Radiography of the chest and axillary region revealed no abnormality, and the baby was admitted to hospital next day without a definite diagnosis being made.

**FIRST OPERATION**, Feb. 23 (patient aged five months).—Aspiration of the tumour produced no fluid. Through

an axillary incision the tumour was dissected out with some difficulty. It was well encapsulated but extended behind the axillary contents as far as the vertebral border of the scapula. The general appearance was that of a lipoma. It was lobulated, yellowish in colour, the centre of each lobule having a pinkish hue

between the nerve-trunks. It was adherent to the scalene muscles and serratus magnus and to the long thoracic nerve, and was removed with some difficulty. No thrombosis was present in the main veins.

The patient was discharged from hospital four weeks later with the clavicle apparently united, but with a



FIG 422—Microscopic appearance of section of tumour removed at five months. H&E (× 75)



FIG 423—Microscopic appearance of section of tumour removed at seven months. H and E (× 75)

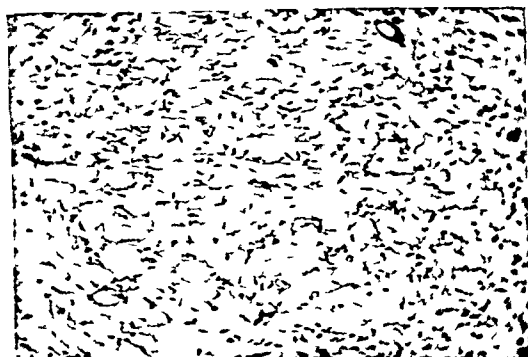


FIG 424—Microscopic appearance of section of tumour removed at eleven months. H and E (× 75)

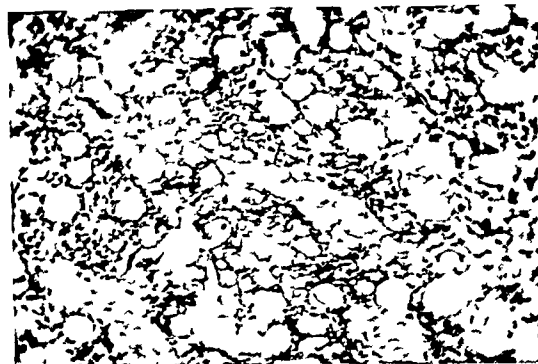


FIG 425—Microscopic appearance of section of tumour removed at thirteen months. H and E (× 75)

The patient was discharged from hospital in twelve days and then attended as an out-patient. Two months later a similar swelling was present in the posterior triangle of the neck and the patient was readmitted.

**SECOND OPERATION,** April 28 (patient aged seven months)—The tumour was dissected out through an incision placed over it. It was encapsulated, except deeply, where it was probably adherent to the site of the previous operation.

A further recurrence was noted in the same position four months later.

**THIRD OPERATION,** Sept 5 (patient aged eleven months)—The tumour was again removed through the posterior triangle of the neck.

Two months later a swelling was apparent in the axilla, and with bimanual examination it could also be felt in the posterior triangle.

**FOURTH OPERATION,** Nov 15 (patient aged thirteen months)—The tumour was removed through combined incisions in the axilla and the posterior triangle.

No further recurrence was observed until seven months later, and it was decided to postpone further operation until the patient was older.

**FIFTH OPERATION,** Oct 2, 1944 (patient aged twenty-five months)—The tumour was visible in both the axilla and posterior triangle. An incision was made above and parallel to the inner two-thirds of the clavicle, the medial end of the incision then turning downwards and outwards to the anterior fold of the axilla. The pectoral muscles and the clavicle were divided. The tumour lay behind the main vessels and nerves, but sent prolongations

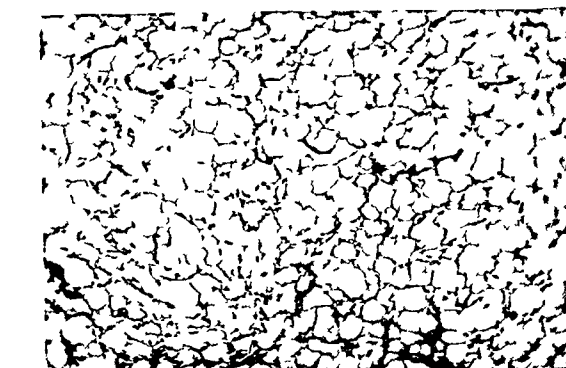


FIG 426—Microscopic appearance of section of tumour removed at twenty-five months. H and E (× 75)

paralysis of the long thoracic nerve. Six months later, after conservative methods had failed, she was readmitted for repair of the ununited clavicle. The tumour had not recurred up to eleven months after the last operation.

After each operation the swelling of the arm diminished and the pectoral veins became less prominent, but these conditions recurred with the tumour. The patient's health and development remained excellent, and repeated radiographs of the chest showed no abnormality.

**HISTOLOGICAL APPEARANCES** (Prof G Payling Wright) (Figs 422-426)—Paraffin embedded sections from specimens fixed in formol-saline were stained with



hæmatoxylin and eosin, with Van Gieson's stain for connective tissue, and by Mayer's mucicarmine method. Frozen sections, stained with Sudan III, were prepared to determine the amount and distribution of the fat.

Materials taken from all five resected masses had fundamentally the same basic histological structure. They were all encapsulated with a thin layer of fibrous tissue, and were rather more extensively vascularized than an ordinary lipoma. Much the greater part of the masses, especially the earlier ones, was composed of a loose, irregularly arranged, network of fine spindle cells with elongated, rather deeply staining, nuclei. These cells tended to be more numerous and more densely packed immediately beneath the capsule and in the vicinity of the main connective-tissue septa. The spaces between the cells were filled with a finely reticular material which stained pinkish with the mucicarmine stain. The appearance generally was closely similar to that seen in a myxoma. There was little evidence of growth, and in an extensive search no mitotic figures were found.

In the frozen sections, some of the characteristic cells were seen to be swollen in varying degrees and to contain fat in some it was present in finely divided droplets, but in the majority of such cells it could be seen as a single large drop resembling that seen in a fully developed adipose tissue cell. Heavily fat-containing cells of this latter kind were often aggregated into small lobular masses, so that areas of a frankly lipomatous nature were interspersed with others that more closely resembled a myxoma.

The main difference observed in the material removed at the successive operations was the progressively increasing proportion of tissue of ordinary lipomatous appearance. In the earlier specimens, the myxomatous areas tended to preponderate, but in the last specimen, removed twenty months after the first one, the whole appearance was scarcely distinguishable from that of a common lipoma.

## DISCUSSION

The recurrences after operation were doubtless in part due to incomplete removal. This was realized at the time, but I was unwilling to inflict an extensive operation on an infant or to face becoming involved in the important structures in a small axilla. Obviously something had to be done from time to time to relieve the pressure on the axillary vein, and the operations performed seemed to achieve this object. The gradual alteration in the histology of the tumour was thought to justify this decision, although the position was rather difficult after the first recurrence. The sections were then seen by several histologists and malignancy was not excluded. No reference could be found to the occurrence of liposarcoma or embryonic lipoma in an infant, and the view was taken that the embryonic appearance was due to the age of the patient and the site of the tumour.

**Site of Origin**—Hatai (1902), Bonnot (1908), and Shattock (1909) each described adipose tissue in the axilla and root of the neck in which the fat cells could be differentiated from those found in ordinary adipose tissue. The fat in the cells tends to be in the form of fine droplets. There are also spindle-shaped cells resembling fibroblasts, lymphoid tissue, and the whole structure is fairly vascular. Even in a five-months-old fetus the surrounding adipose tissue is of the adult type, and this specialized structure can be differentiated from adipose tissue in adult life (Shattock). Hatai first suggested that this tissue represents the hibernating gland of animals, best developed in the hedgehog and dormouse. Whether this organ is different from the so-called dark adipose

tissue present in the prevertebral and inguinal regions is uncertain, but there is a great histological similarity. However, in all these situations adipose tissue of an embryonic type tends to persist, and it is of interest that liposarcomata tend to occur in the scapular and prevertebral regions. There is also a possible tendency for common lipomata to appear in those regions where normal deposits of fat occur in the animal world or as human racial peculiarities. The camel's hump, the fatty tails of marsupials and certain breeds of sheep, the fat thighs of the ancient Egyptian women, and the fat buttocks of Bush-women, all have their counterparts in lipomatous tumours.

It is probable that this tumour arose from the persistent embryonic adipose tissue in the inter-scapular gland.

**Histological Changes**—The endocrine control over fatty deposits is evident in pituitary disease and cretinism. The occurrence of multiple lipomata, often symmetrical, suggests that lipoma formation may also be the result of failure or perversion of a general controlling influence, possible endocrine. The existence of mixed lipomata (myolipomata, fibrolipomata) and lipomata connected with spina bifida suggests that the controlling factor is a general one affecting the development of many types of connective tissue from a common embryonic cell.

A generalized fatty deposit may be a reversible state, but a lipoma seems to be as autonomous as any other tumour. Admittedly, as Shattock pointed out, a few lipomata have been described which may have diminished in size during emaciation, but there is some doubt as to the authenticity of these cases. Tumours, even if malignant, may be affected by endocrine factors, as shown by the effect of oestrin on some neoplasms. However, once a neoplasm has formed, it rarely alters except to a more embryonic or malignant type, although it is possible that the histology and rate of growth are influenced by a general controlling factor.

The tumour under discussion appears to have arisen from persistent embryonic tissue at a time of life when the transformation from connective tissue to fat is very active (Geschickter, 1934). The factors controlling cell growth at this stage of development must be very strong, and, although originally embryonic, the tumour seems to have remained in touch with these factors sufficiently to be altered into at least an obviously innocent tumour.

## SUMMARY

- 1 Serial sections are shown of the transformation of an embryonic lipoma to an adult-celled lipoma.
- 2 The site of origin of the tumour and the reasons for its transformation are briefly discussed.

My thanks are due to Professor G. Payling Wright for the pathological report and for his helpful criticism of this article. I should also like to thank Mr J. E. Andrews, of the Southern Group Laboratory, for taking the microphotographs.

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# MASSIVE HÆMORRHAGE FROM A PEPTIC ULCER IN A MECKEL'S DIVERTICULUM IN A FEMALE CHILD OF ELEVEN MONTHS

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THIS case is of interest as it is one of the few on record where a successful operation was performed on a child below the age of one year for the relief of hæmorrhage from a peptic ulcer in a Meckel's diverticulum

## CASE REPORT

**HISTORY**—M D, a female child aged 11 months, was first admitted to another hospital on May 28 with melæna of one day's duration. The condition cleared up while in hospital, and the child was discharged. Bleeding recurred almost immediately, necessitating readmission on June 4. The stools varied in colour from dark brown to bright red, and the blood appeared to be intimately mixed with the fæces. On June 7 the hæmoglobin was 36 per cent and two transfusions totalling 180 c.c. were given into the bone-marrow. The bleeding continued intermittently, and as the temperature ranged between 99° and 102° F a course of sulphasuxidine was begun on June 10. The hæmorrhage now ceased. Microscopical examination of the fæces on June 11 showed some mucus, but no blood, pus, or protozoa, and culture for organisms of the dysentery group was negative. On June 14 the bleeding time was 3 minutes, the clotting time 5 minutes, the platelet count 205,000, and the fragility and size of the red cells were normal. The child appeared to be losing ground, and as further bleeding occurred on June 28 she was transferred to the Leeds General Infirmary under the care of Professor C W Vining.

**ON ADMISSION**—The child was well nourished, but pale and irritable. Full clinical and radiological examinations were negative. One large melæna stool was passed shortly after examination was completed. A blood-count showed red cells 1,500,000, hæmoglobin 28 per cent. Following transfusion (one pint Group O blood) there was oozing of fresh blood from the rectum. During the night of July 5 the child experienced a massive intestinal hæmorrhage of almost pure blood. On July 6 she received a further pint of Group O Rh + blood, after which her hæmoglobin rose to 78 per cent.

On the same day, Professor P J Moir was asked to see the child, and a provisional diagnosis of ulcerated Meckel's diverticulum or intestinal hæmangioma was made, exploratory laparotomy being suggested.

**AT OPERATION**—Laparotomy was carried out on July 9. About 18 in from the ileocaecal valve on the antimesenteric border of the small intestine a small rubbery white nodule was found. The tumour was removed, together with a portion of the surrounding bowel. Except for a little vomiting on the second day, convalescence was uneventful. The child was discharged on July 21 and no further bleeding has been noticed.

**THE SPECIMEN**—For a report on the histology of the tumour, I am indebted to Dr C J E Wright, of the Pathological Department of the Infirmary. "Naked eye the specimen appeared to be a small elliptical portion of bowel wall with a white nodule measuring about 0.7 cm diameter by 0.3 cm in height projecting from the serosal surface. On section no evidence of tumour could be seen and the projection appeared to be a small Meckel's diverticulum.

"**Histology** (Fig 427)—This is a Meckel's diverticulum showing a relatively large area of gastric heterotopia involving the wall of the Meckel together with the surrounding intestinal wall almost as far as one of

the edges in the long diameter of the specimen. The gastric type mucosa shows typical oxyntic cells and the adjacent intestinal epithelium what is virtually a Peyer's patch. An ulcer is present in the diverticulum and



FIG 427—Microphotograph showing ulcer and gastric glands ( $\times 30$ )

shows a small thrombosed vessel in the floor, quite possibly the source of the hæmorrhage. Owing to the presence of the heterotopic gastric mucous membrane the ulcer may be regarded as of peptic type."

## DISCUSSION

Out of 30 diverticula examined by Schaeetz (1925) 5 were found to contain gastric glands. Roughly the same incidence in heterotopia has been the finding of several other observers (Greenblatt, Pund, and Chaney, 1931, Curd, 1936). Brown and Pemberton (1936), however, discovered gastric mucosa in 13 cases out of 55 (24 per cent), Farr and Penke (1935) in 6 cases out of 13 (46 per cent), while Hudson and Koplik (1932) were able to demonstrate heterotopia in 67 per cent of a large series. If we regard the incidence as about 30 per cent, and the occurrence of Meckel's diverticulum as 2 per cent, then the possibility of gastric epithelium is roughly 1 in every 170 persons.

Deetz, in 1907, was the first to draw attention to the peptic nature of the ulceration, though cases had been reported by von Denecke (1902) and Hilgenreiner (1903). Gubal (1924) expressed the belief that it is this type of diverticulum which ulcerates, causes hæmorrhage, and occasionally perforates, with subsequent peritonitis. This is also borne out in the experience of Stulz and Worringer (1925), who state that the cause of the hæmorrhage or perforation is to be found in the ulceration of the heteroplastic gastric mucosa. That this is not the whole story, however, is shown by the fact that bleeding associated with heterotopia, but without ulceration, may occur (Abrams, 1938). With regard to this, Taylor (1927)

says "A possible explanation is that an active acid secretion formed by the heterotopic glands may have devitalized the neighbouring intestinal epithelium and rendered it susceptible to an infection which would otherwise be easily overcome"

This condition is most frequent in children Cobb (1936) found that 74 per cent of cases of peptic ulcer in a Meckel's diverticulum were in children from 1 to 15 years, while Matt and Timpone (1940) reviewing the literature, discovered that out of 76 histologically proved cases, 42, or just over 56 per cent, occurred under the age of 10 years, and 72, or roughly 94 per cent, were under the age of 30

The cardinal sign is profuse repeated intestinal hæmorrhage Pain is a very variable feature which may or may not be present Should the ulcer perforate, there is superimposed the picture of an acute abdominal emergency

The youngest case I have been able to find where a successful operation was performed is that of Fevre, Patel, and Lepart (1930), where a diagnosis of intussusception was made in a child aged 5 months who was bleeding from the rectum, and who had the signs of an acute abdomen operation revealed a perforated Meckel's diverticulum which, histologically, showed an ulcer at the junction of the ileal and gastric mucosæ Reports of similar cases under 1 year include those of Bunne (1936), Mason and Graham (1932), Moore (1926), Mallory (1936), Weiner and Seley (1939), Montgomery (1932) Conrad (1941), and Tisdall (1928)

The possibility of a diverticulum should be kept in mind in any case of profuse intestinal hæmorrhage, especially if repeated In intussusception the blood is mixed with mucus, a tumour can generally be felt, either abdominally or more rarely (and fatally) per rectum, and there are the characteristic screaming attacks with drawing up of the legs Local conditions such as rectal polypi or ulcerative colitis can be excluded by endoscopy Bacteriological examination of the stools will show the presence of dysenteric organisms Henoch's purpura may be ruled out by the absence of purpuric spots, of severe colic which is usually a feature, and of swelling and pain in the joints Purpura hæmorrhagica shows a diminished platelet count Hæmophilia is to be considered in the male child here the disease may be manifest in the first six months of life (Price, 1941), but the family history and the blood findings will help to establish the diagnosis Hereditary telangiectasia is so rare that mention is made only in passing Rectal bleeding in the first few days of life is usually due to hæmorrhagic disease of the newborn or acute ulceration of the duodenum, but Moll's case (1926), where bleeding occurred intermittently from the second day up to the fifth month, and where post mortem a huge diverticulum with two chronic ulcers at its junction with the ileum was found, does suggest that peptic ulcer in a Meckel's diverticulum can also cause hæmorrhage at this early age The most difficult conditions to exclude are an intestinal polyp

or hæmangioma, but in both cases abdominal section will be required

**Treatment**—The treatment for the condition is removal of the diverticulum Blood transfusion will be required in most cases as a pre-operative measure Greenwald and Steiner (1931) give mortality figures of 7.6 per cent before perforation of the ulcer, and 58 per cent after perforation

## SUMMARY

A case of peptic ulcer in a Meckel's diverticulum in a female child aged 11 months is reported Complete recovery followed removal of the diverticulum

I should like to express my thanks to Professor C W Vining, Consulting Physician to the Children's Department, for his encouragement in writing this article, to Professor P J Moir, Professor of Surgery in the University of Leeds, for kind criticism and access to the operation notes, to Dr L Moss for notes on the child's progress before admission, and to the Sister and nurses of the Children's Department for their aid in the post-operative period

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## AMÆBIC GRANULOMA OF THE SKIN

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AMÆBIC granuloma of the skin, or amœbiasis cutis, an uncommon lesion due to infection with the *Entamœba histolytica*, crops up periodically in the literature both on account of its rarity and the interesting pathological and clinical picture it presents

*E. histolytica* may, under certain conditions, invade the skin and cause extensive ulcerative granulomatous lesions, but blood-stream invasion has never been reported. The lesions practically always arise by direct continuity from some other focus of the disease, e.g., drainage tract from the liver, the site of aspiration of the liver, around a colostomy wound, or from the rectum

Although primary infection of the skin, according to Craig (1944), is reported rarely, a number of authors report ulcerative skin lesions around the anus. Crawford (1933) reports a case following an amœbic abscess of the perineum, the secondary lesion involving both buttocks. Engman and Meleney (1931) give an excellent description of the pathology of the skin lesions caused by the *E. histolytica*. According to these authors, it is characterized by a rapidly spreading ulcerative process, which, owing to the rapidity of its spread, has an irregular border and overhanging edge, from under which pus can be expressed, and a floor which is lined with indolent granulation tissue. The ulcer is painful and extremely tender.

Tixier and others (1927), under the name 'poroderme amibienne', describe lesions of the peri-anal region. In their case (chronic dysentery of six years' duration) entamœbæ were found in the pus. Ngai and Frazier (1933) give a very complete review and describe 3 cases. L. F. Hamburger (1925) reported a case with a tumour in the right lumbar region, discharging liver pus. Sections of tissue from the edge of the ulcer showed, on suitable staining, the presence of amœbæ. F. L. and H. E. Meleney (1935) describe a very interesting case of a Chinese patient who, a month before admission, noticed a small, hard, tender lump to the right of the anus. This increased in size for three weeks, the patient being unable to sit down. Ten days prior to admission the lump burst, discharging foul pus. The patient was a severe diabetic, and on admission had a large, foul-smelling ulceration, extending from the upper margin of the sacrum to the upper third of the thigh and to the perineum. The line of demarcation was relatively smooth and sharply outlined. Four days after admission the ulcerative area was excised. Emetine hydrochloride was given as soon as the diagnosis was made, the diabetes being controlled at the same time. On the twenty-first day a Reverdin graft was applied, the patient subsequently being discharged, fully recovered.

Manson-Bahr (1938) describes a case of ulceration of the abdominal wall secondary to colostomy for supposed carcinoma of the rectum. *E. histolytica*, however, was found in sections of the ulcer, the condition clearing up on emetin therapy. W. B. Gabriel (1945) reports a case, very similar to that of the Meleney's, of extensive amœbic ulceration of the abdominal wall and buttocks. The primary lesion appeared to be a perirectal abscess. Treatment by emetine cleared up the infection. Thiersch grafts were subsequently applied, with complete healing. Manson-Bahr (1943) is of the opinion that amœbiasis cutis occurs chiefly as an unsuspected secondary infection of papillomata, usually of the anal region. More recently McConaghey (1945) states that only 19 cases of proved amœbiasis of the skin, perineum, and buttocks have been reported in the literature. Of these, the majority occurred in China. He describes a case of an Anglo-Burmese lady, who, after having blood and mucus in the stools, developed a blind peri-anal 'boil'. On admission she had a large fungating mass, the size of a walnut, around the anus. The serous exudate showed abundant trophic amœbæ. Here again, the condition cleared up completely with six doses of emetine.

In South Africa amœbic infection is of common occurrence, particularly in Natal, where the infection amongst the non-European community is quite high. On the Witwatersrand there is also quite an appreciable incidence, which Osburn (1943) attributes to two factors: (1) Exposure from the presence of natives from Natal and Nyasaland, and (2) Visiting of these territories by residents of the Witwatersrand.

From the above brief review it appears that amœbic infection of the skin of the buttocks is most unusual, and as such, any case presenting these features is worth recording.

The following case is therefore of considerable interest in that the pathological features of amœbic granuloma of the skin of the buttock are well demonstrated.

## CASE REPORT

**HISTORY**—I. v. St., a young adult male Griqua (coloured), aged 28 years, a painter by trade, was admitted on March 20, 1945, to the surgical wards of the Coronation Hospital, with the diagnosis carbuncle (?), sarcoma of the buttock (?). The following history was elicited. For the last year he had not been quite well, suffering from frequent attacks of colicky, lower abdominal pain, usually associated with diarrhoeal stools. In the intervals, however, he was quite well, although he lost some weight during this period. There was no vomiting, no intermittent fever, malaise, headaches, or similar evidences of toxic disturbances. He occasionally noted some blood in the stools, but no mucus. Appetite during this period was good and there had been no general health disturbance. He had a slight cough for the last few years, accompanied by some sputum, but no hæmoptysis.

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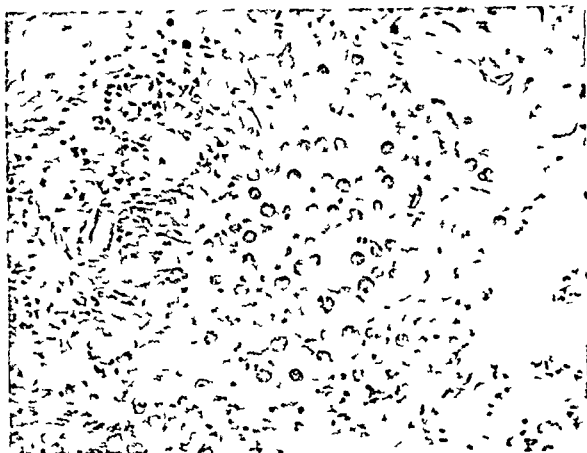


FIG 428 —Showing amebæ in margin of ulcer—active forms ( $\times 150$ )

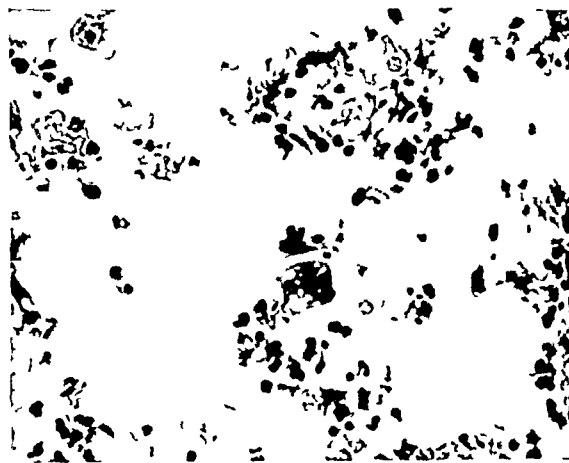


FIG 429 —Same as Fig 428, showing more clearly the active forms of *Entamoeba histolytica* ( $\times 400$ )



FIG 430 —Photograph of the ulcer before treatment



FIG 431 —Showing the deep excavating nature of the ulceration

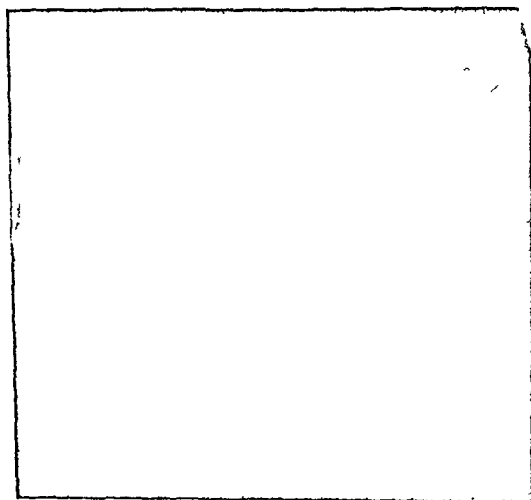


FIG 432 —The colostomy

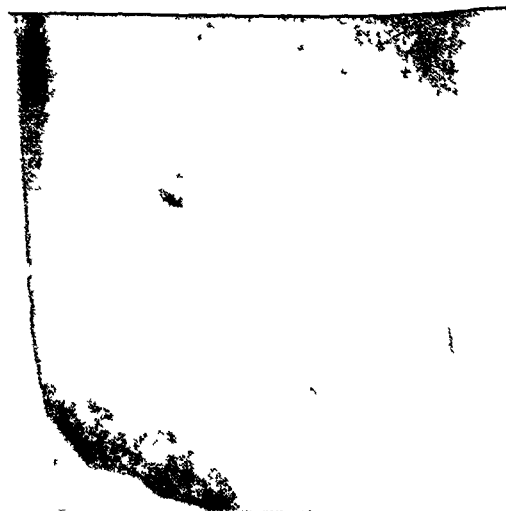
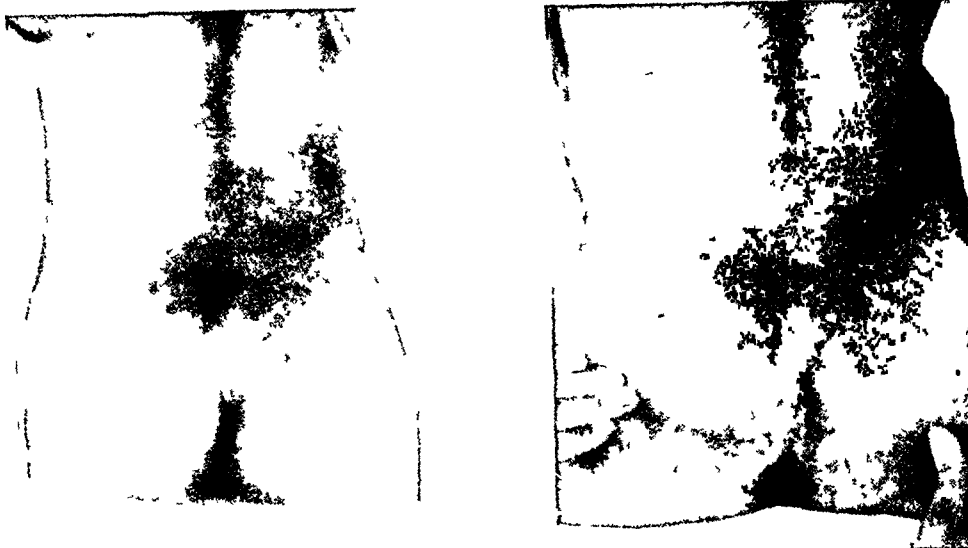


FIG 433 —After intraperitoneal closure of the colostomy

The present complaint started one month ago as a small "pimple" on the left buttock. This increased in size and became painful, the pain being of a throbbing nature. He was given an ointment by a doctor and shortly afterwards the swelling "burst", discharging

wall of which amœbæ were found (South African Institute of Medical Research) (Figs 428, 429). Examination of a stool on March 29 revealed the presence of ova of *Ascaris lumbricoides* and flagellate forms of *Trichomonas hominis* pus, mucus, and red cells, but no amœbæ.



Figs 434, 435 —Showing complete healing

pus. The resulting ulcer apparently has been increasing in size rapidly and the patient was losing weight markedly by the time he was admitted to this hospital.

**ON EXAMINATION**—His temperature was 99.4° F, pulse 104, respirations 22. There was evidence of dehydration and loss of weight. Local examination revealed a large ulcer of the left buttock, extending obliquely across the sacrum to the opposite buttock, about 5 in in length and 2 in wide. The edge was raised, but not undermined, sloping into the floor of the ulcer, which was covered with dirty, sloughing granulation tissue. The surrounding tissues, for about 1½ in, were swollen and indurated. The nearest point to the anus was about 2 in. The ulcer and surrounding tissues were extremely painful and tender to the touch. The regional lymphatic glands (left inguinal) were moderately enlarged and tender.

Examination revealed a few rales at the base of the right lung. Heart, abdomen, CNS were normal. The blood-pressure was 120/80.

Genito-urinary history and examination were negative.

**Laboratory Examinations** (March 22)—Complete blood-count: RBC's 4,870,000, CI 101, Hb 98 per cent. Leucocytes 15,300, polymorphonuclears 74.5 per cent, large mononuclears 10 per cent, lymphocytes 22.5 per cent, eosinophils 1.5 per cent, basophils 0 per cent, metamyelocytes 0.5 per cent. The red cells showed slight anisocytosis, but otherwise no significant changes. The polymorphonuclears showed a slight shift to the left and evidence of early toxic granulation. WR was negative.

**TREATMENT**—When seen in the ward the condition looked so like a breaking down carbuncle, that treatment for this condition was instituted—urea dressings and short-wave therapy. The condition did not respond, but the ulcer rapidly increased in size. Thin mucopurulent faeces were constantly escaping per anum and contaminating the ulcer area.

On March 26 sigmoidoscopy was performed, revealing a large, necrotic ulcerating area covering the posterior rectal wall. The colon could not be examined. A wedge was resected out of the wall of the ulcer. Section of this specimen showed the presence of an ulcer, in the

On account of the sloughing condition of the rectum and the contamination of the ulcer, a left inguinal colostomy was done on April 3 in order to divert the contents of the colon. Treatment with emetine hydrochloride was commenced—½ gr b d for twelve days. There was an almost immediate and miraculous response. Concomitantly chiniofon instillations (2½ per cent) in both proximal and distal loops of the colostomy were given, as well as local chiniofon dressings.

The temperature returned to normal, appetite and sleep improved, and there was immediate evidence of healing and retrogression of the ulcer. On May 21, six weeks after commencing emetine therapy, a full-thickness graft was applied to the now cleanly granulating area. A second course of emetine was started on May 23. A portion of the graft unfortunately sloughed, but sufficient took to ensure healing of the ulcer. On July 25 the colostomy was closed, using the intraperitoneal method, followed by another course of emetine for ten days, plus a course of emetine bismuth iodide. The patient was discharged on Sept 8 healed except for a slight discharge from the colostomy wound, which healed completely subsequently. When seen again in the out-patient department the patient was quite well, had put on weight, and generally had recovered from his malady.

## COMMENT

Under certain conditions, *E. histolytica* may invade the skin and subcutaneous tissues of the buttocks and peri-anal regions, causing acute, rapidly spreading ulceration with marked constitutional disturbance. Spread is probably by continuity from infection of the rectum, or via the lymphatics, rarely by the blood-stream. The local lesion is slightly raised, with steep, at times undermined edges, surrounded by an area of induration showing all the characteristic signs of inflammation. The floor of the ulcer is covered with sloughing granulation tissue, the whole entity being extremely painful and tender. Any condition around the anus

conforming to this pattern should warn the medical attendant of a possible amœbic infection of the lower bowel—examination of the stools and a biopsy are necessary for final diagnosis. The response to emetine is miraculous, and this can be used as an effective therapeutic test.

### SUMMARY

1 A brief review of the literature on amœbiasis cutis is given.

2 An interesting case of amœbic granuloma of the buttocks is discussed.

3 In acute ulcerative peri-anal conditions not responding to usual chemotherapeutic methods, a therapeutic test of emetine hydrochloride is justifiable. Stool examinations and biopsy for *E. histolytica* should be done.

The authors wish to thank Dr F K Mills, Superintendent of the Johannesburg General Hospital, for permission to publish the case, and Dr Simpson and Mr Brandt the former for making

available a microscopical section, and the latter for the microphotographs, both of the South African Institute of Medical Research, also Dr G S Chenuk for kindly taking the photographs.

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## TOOTH PLATE IMPACTED IN GULLET FOR FIFTEEN YEARS REMOVAL BY TRANSTHORACIC ŒSOPHAGOTOMY

By G GREY TURNER

### CASE REPORT

**HISTORY**—The patient, E C, aged 52, a married woman, was admitted to Hammersmith Hospital in November, 1945, with the story that she had swallowed a denture fifteen years previously. Her memory of the occasion was very vivid and she could confirm the date as Jan 3, 1931, for it was the same day as a serious accident to her brother-in-law whose leg had to be amputated in consequence. An experience of seven years as surgical registrar in the Newcastle-upon-Tyne Infirmary taught me how easy it is for a patient to be wrong about matters of history, even to the extent of a year or two, so great care has been taken to verify the date in this case, and I am indebted to the patient and to her medical attendant for assistance on this point and with regard to other items of the history.

When the misadventure occurred the patient was at midday dinner, which consisted of roast chine of pork, onion stuffing, and roast potatoes, which she very much enjoyed. During the meal the patient suddenly noticed that her tooth plate had disappeared and exclaimed "Oh, I have swallowed my teeth." The denture was an upper one with two front teeth, she knew that it was defective and ought to have been repaired, but at the time she was unable to afford to have this done. As she had no pain or inconvenience the patient finished her meal and then completed the weekly washing, afterwards cleaning up the wash-house before she sat down to rest. The doctor was sent for and made an examination of the mouth, but without using instruments, he also felt the neck and told the patient that the teeth were not in the throat. At that time there was no X-ray or œsophagoscopic investigation. She was assured that the teeth would probably pass and, in the hope of aiding matters, was put on a diet of dried bread with very little to drink. This diet was continued for about a week, when she had a very hard and difficult evacuation and was told that the teeth had probably come away, though no special examination of the stool was made. Thereafter she remained quite well and symptom-free for

about three months, when she first noticed a pain up the right side of the neck reaching as far as the ear. Again the doctor was consulted, but assured her that the teeth had dissolved and that the pain was probably nervous. After this reassurance the patient felt quite well for ten years, when she gradually began to experience a little difficulty in swallowing. At first this was only associated with solid foods, but it became slowly and steadily worse and especially so during the past year. For the last two years the patient had only been able to take soft food and had to be very careful in swallowing. She also had pain on the right side, said to be due to pleurisy and was in bed about three weeks and had cough but never brought up blood. During the summer of 1944 she had various symptoms of discomfort in the chest and upper abdomen attributed to the menopause. There was pain in the epigastrium and sickness. About Jan 2, 1945, the patient was taken very ill with pain across the lower chest and in the upper abdomen, but this was not obviously connected with swallowing. A surgeon who was called in was not satisfied with the diagnosis of gall-stones which had been made. When doubt was expressed about the diagnosis the patient volunteered the information that she had previously swallowed her tooth plate and asked if her doctors thought this might have anything to do with her trouble. Because of this disclosure a radiograph was taken, which showed a dark shadow in the thoracic œsophagus which might have been a foreign body, but a throat specialist declared that all was in order. In spite of this finding the patient went into hospital for an abdominal operation early in June, 1945. The gall-bladder was found to contain small stones and was removed. The patient made a good recovery and returned home, but after a week or two had worse trouble with swallowing than ever before. Both liquids and solids seemed to stick just behind the middle of the breast bone and produced great pain. The pain on swallowing was also very bad and the patient could only get relief by bringing up whatever she had attempted to swallow. The regurgitated material was unaltered food. In the mornings before taking food

she brought up quantities of mucus. The doctor prescribed medicine which sometimes eased the patient, but not always. The retrosternal pain, sickness, and malaise persisted. In retrospect the patient realized that during the last three years she had lost ground, and about 2 st in weight, and often had to ask assistance with her household duties. Her new medical attendant, Dr J R Baker, of Winterton, in Lincolnshire, the doctor whom she originally consulted having died, began to wonder if the teeth really were still impacted in the œsophagus and if they might be the cause of her pain. As a result of talking over the matter with the author, it was decided that the patient should come to Hammer-smith Hospital for investigation, and she was admitted here under my care.

ON ADMISSION.—She was a slightly built woman about 5 ft in height, of calm demeanour, and apparently reasonably good health. While not obviously robust, she was of the wiry type and throughout proved herself



FIG 436.—Radiograph showing what was taken to be a fixation wire on the tooth plate. It was situated opposite the body of the 9th dorsal vertebra.

most co-operative and helpful. Her only complaint was of difficulty in swallowing, with some pain and soreness on the right side of the neck extending from the clavicle to behind the ear. She was also somewhat concerned that she felt rather weakly and continued to lose weight. Pulse and temperature were normal and a full ordinary examination did not elicit any abnormal physical sign.

A plain X-ray examination made the day after admission showed a linear opacity lying obliquely in the position of the œsophagus at the level of the 9th thoracic vertebra (Fig 436). The opacity was about  $\frac{1}{2}$  in long, about the thickness of a piece of dental wire, and slightly curved. In fact, it had just the appearance of a fixation wire on a dental plate, but neither teeth nor plate were seen. Dr Duncan White tells me that on re-examination he thought he could discern the shadow of two teeth, but there was certainly no delineation of a tooth plate which could be detected by an ordinary observer. The administration of an opaque medium confirmed the relationship of the foreign body to the œsophagus and at the site the bolus of medium was distorted. Thus the appearances were compatible with a tooth plate with a fixation wire impacted in the œsophagus. At this time the patient was able to take soft food apparently without difficulty, but she was very careful during the act of swallowing.

On Dec 3, Mr Ivor Griffiths made an œsophagoscopic examination, using intravenous anaesthesia. The upper part of the gullet was normal, but at the position indicated by the X-ray shadow there was a slight constriction (as was said, but not recorded, "the appearances were those of stenosis, but with a wide mouth"). Just beyond was a mass of granulations which bled very freely on the slightest touch. Amidst this granulating area the sharp edge of a vulcanite tooth plate could just be seen, though it was almost at once obscured by bleeding. The actual teeth were not visible. With a suitable forceps the edge of the plate was grasped, but it was firmly fixed at the site of impaction, for it could not be drawn upwards or pushed down, though it could be very slightly moved. It could not have been dislodged, at least upwards, without using great and unwarranted force. It seemed certain that the foreign body was lying in an ulcerated area and that the œsophageal wall was softened and friable and might readily be torn or perforated by some unguarded movement of the hard substance. The question of breaking the plate and removing it in fragments was considered, but the least manipulation brought on free bleeding and with vivid pictures in mind of several examples of injury to the aorta by foreign bodies it was concluded that any such attempt would be most unwise. The patient was just a little upset by this very careful and restrained examination. She felt slightly cold, had slight pyrexia, and experienced more tenderness on swallowing for a day or two. A further radiograph made three days afterwards showed the wire a little lower than before and so altered in contour as to suggest that the tooth plate had been slightly rotated. There was a more marked degree of obstruction to the passage of a swallowed opaque medium. Meanwhile, I had been giving thought to the proper management of the case and had decided to carry out œsophagotomy, using a left-sided transthoracic approach. The consideration which led me to this conclusion are set out in the Commentary. Care was taken to prepare the patient. Her general condition was daily improving as the result of hospital routine and feeding, so that from the nutritional point of view it did not seem necessary to carry out preliminary gastrostomy. A course of sulphamylamide and 100,000 units of penicillin were administered.

AT OPERATION.—The operation was carried out on Dec 11. The intratracheal method of anaesthesia with gas, oxygen, and ether was most satisfactory. The incision was made in the seventh interspace, extending from the edge of the sternum right back to the edge of the erector spinae. The exposure after rib-spreading was satisfactory and it was not necessary to divide ribs. The general pleural cavity was normal looking and entirely free from adhesions. The descending aorta seemed to be longer and much more prominent than usual and completely obscured the œsophagus, and the sulcus on its inner side between this vessel and the œsophagus was so deep as to be very striking. As a first step, the inferior pulmonary ligament was divided. The œsophagus was then easily exposed and palpated and the foreign body located just a little below the lung root. The pleura overlying this part of the œsophagus was slightly reddened and a little thickened, it was incised vertically from just above the diaphragm to a point about an inch below the site of impaction of the plate. It was somewhat thickened at the upper end of this incision and the texture than normal, and seemed to bind the tissues together. At no point was the œsophagus adherent to the aorta and separation of the œsophagus from its surroundings was easy. At the site of impaction the œsophagus felt hard and simulated a malignant new growth, though just below this area it was actually a little dilated with a rather softer wall than normal. The œsophagus was bluntly mobilized by the finger and



elevated from its bed with the help of a ring forceps. The cellular tissue was protected by gauze wrung out of flavine solution and the œsophagus opened between guide sutures introduced into its wall just below the level of the impacted foreign body. The incision was about  $1\frac{1}{2}$  in long and planned so that its upper extremity was situated  $\frac{1}{2}$  in below where the foreign body lay. I was afraid that if carried higher it would extend into an ulcerated area surrounding the tooth plate and that this part might not heal satisfactorily. Except for some thickening from œdema, the œsophageal wall was apparently normal, and on opening its lumen there was only a little mucus, easily wiped away.

The finger, passed up the œsophagus, disclosed a slight narrowing just below the ulcerated area in which the plate was lying, but the edge of the latter could readily be felt as the tip of the finger easily went through the narrowed area. With a pair of angulated necrosis forceps the plate was grasped, and though it could not



FIG 437—The tooth plate after removal ( $\times 7$ )

immediately be drawn down, it was slightly rotated and then easily manipulated free and removed. There was no bleeding and no free escape of purulent discharge and, in fact, nothing but what could be readily mopped away without soiling the parts.

It had originally been intended to suture the incision in the œsophagus in the transverse direction after the principle of pyloroplasty and a suture was placed through the upper and lower angles of the incision as a first step in this stage, but the ends of the incision did not approximate readily and, in fact, the upper one could not be drawn down at all. The suture was therefore removed and the incision carefully closed vertically. The mucous membrane, which seemed unusually voluminous, retracted quite considerably, but four interrupted sutures, passed from within the lumen, brought its edges together. The muscular wall, which was twice as thick as usual, was then carefully approximated by half a dozen lightly tied sutures, i.e., lightly tied in order not to cut through the softened and œdematous muscle. About six other sutures were used to bring together loose tissue over the site of the incision but the cellular tissue was scanty, probably due to the peri-œsophagitis. When completed the closure appeared to be entirely satisfactory. The end of the last stitch was left uncut and a drainage tube  $\frac{3}{8}$  in in diameter, and without side holes, was threaded along it until it reached the lower end of the œsophageal incision. The idea was to provide a direct track to the surface in the event of leakage. A powder of sulphanilamide and flavine was scattered around about the area.

It had been intended to draw the posterior pleura over the sutured œsophagus, but that structure proved to be friable and, what is more, was rather fixed and would not come readily together, so perforce had to be left open. The chest was carefully closed. The tube was brought

out at the extreme anterior end of the parietal incision, which it was judged would be the most dependent spot with the patient in the sitting posture. At the end of the operation it was observed that there was no sucking of air either through the tube or by its side. Penicillin, 10,000 units, was instilled along the tube. There were no unusual features during the operation and the patient tolerated the intervention without causing the slightest anxiety.

**PROGRESS**—The after-progress was entirely uneventful, it was almost afebrile, and the pulse, which was never quicker than 105, was normal by the end of the week.

On the day following operation 100,000 units of penicillin was given by the intramuscular route and sips of a penicillin solution were given. Nothing else was allowed by the mouth for four days, during this time she had fluids both intravenously and per rectum. Thereafter mouth feeding was gradually advanced and by the end of a week she took a sufficiency of semi-solid food and by the end of the second week ordinary careful diet, and thereafter



FIG 438—Radiograph of plate after removal. It shows the buried wire.

the full diet of the hospital. There was never any discharge from the tube and no moisture, it was removed on the eighth day. The incision in the parietes healed *per primam*.

On the first day of January, 1946, i.e., just three weeks after operation, X-ray examination showed some slight dilatation of the distal portion of œsophagus, but there was no sign of obstruction. By that time the patient was swallowing normally, feeling in every way quite well, and was gaining weight. She left the hospital exactly 22 days after operation and travelled to her home, a distance of 129 miles, by car. Since then she has steadily improved and considers that her health is quite restored to normal.

In April she was reported as very well and had gained  $17\frac{1}{2}$  lb since operation. She was doing her own housework and eating with relish things she had not touched for years. In November the patient reported that she was perfectly well in every way.

The plate was of the shape and size shown in Fig 437. Its length was  $1\frac{3}{4}$  in, width  $1\frac{1}{4}$  in, and greatest depth  $\frac{1}{2}$  in. (The average transverse diameter of the œsophagus at the site of impaction is usually regarded as  $1\frac{1}{4}$  in.) Except that it was completely blackened, it was apparently unchanged as the result of its long sojourn in the œsophagus. The wire, seen in the films taken *in vivo*, is embedded in the material of which the plate is made. It weighed 36 gr and appeared to be of the ordinary vulcanite composition, but no analysis has been made. As the plate may be said not to have shown in the body it was X-rayed, with the result shown in Fig 438.

### COMMENTARY

In this case I felt it wise to approach the problem from the point of view of pathology and assume that most likely the tooth plate had caused

extensive pressure necrosis in the œsophagus and was lying in an ulcerated area which might even be involving the adjoining aorta. In such circumstances it seemed unlikely that the plate could be safely removed endoscopically because of the way in which it was probably embedded, and in consequence there would be considerable risk in that form of removal which might result in serious trauma precipitating disaster. My first view was, therefore, that the foreign body should be approached by a direct incision into the œsophagus under the unimpeded guidance of the eye, using the transthoracic route.

Because I assumed that there would be a very considerable degree of sepsis about the tooth plate, with risk of infection of the cellular tissue and the

equally striking, rendering the route most uninviting (Fig 439). At the same time it must be recognized that the subject was one of those very rigid formalin-prepared bodies where all the structures are much hardened and to add to the trouble the left lung was almost solid. In life I am sure the difficulties would be somewhat less than we encountered, though there is no way that I can imagine of overcoming the obscurity produced by the aorta and the great depth of the œsophagus from the surface. I therefore reverted to the idea of a transthoracic approach, which had the great advantage of familiarity as well as accessibility.

Before finally deciding to deal with the problem by this route it was considered that despite the long period of impaction and the probable ulceration we

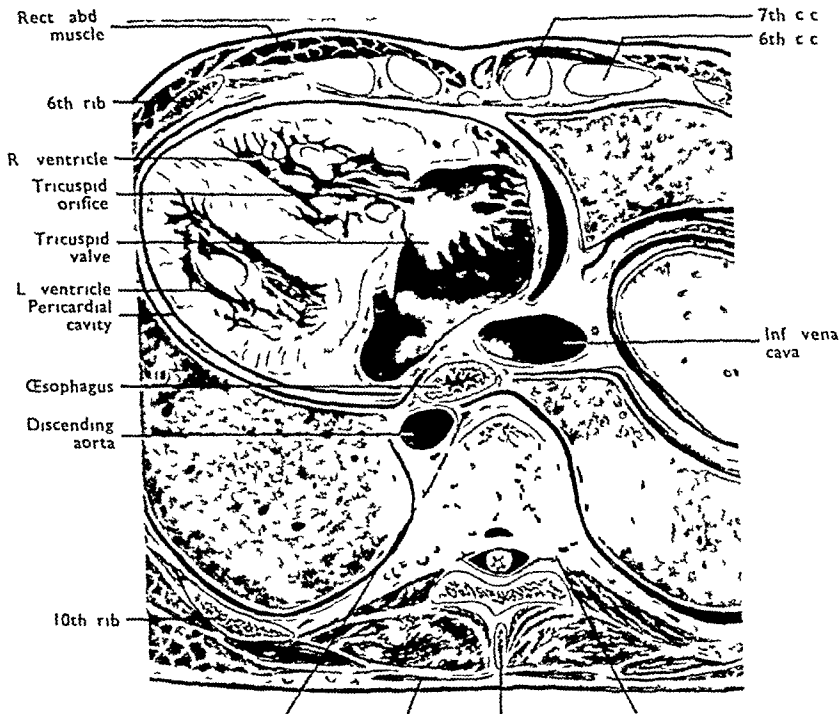


FIG 439 —Transverse section of the thorax through the 9th dorsal vertebra, showing the depth of the œsophagus from the posterior surface (From Symington's 'Atlas of Topographical Anatomy')

pleura, I next had in mind the approach to the œsophagus by the posterior mediastinal route. There was also the fear that during removal the œsophageal wall might be torn and would not heal satisfactorily, and that a fistula would be a probable sequel. For these reasons I assumed that drainage had better be directly posterior rather than across the pleural cavity. Working on the cadaver, I again tried out the posterior mediastinal approach from the left side. This emphasized the difficulties of this route due to the depth of the œsophagus, which was about 4 in. from posterior skin surface, and also the way that the œsophagus was obscured by the great prominence of the aorta.

On another occasion I got my assistant, Mr D. M. Douglas, to try out a similar approach from the right side on the same cadaver. Although the prominence of the aorta was no longer a barrier, the depth of the œsophagus from the surface was

ought to look at the foreign body endoscopically to determine if the plate could perhaps be extracted that way—if not unexpectedly easily, at least without undue difficulty and trauma. This plan was especially considered because on the X-ray films only the gold band could be seen, the tooth plate itself not casting any shadow, and I thought it possible that part of the plate had broken away, thus rendering its removal easier. As the record shows, the plate was firmly impacted and it was not considered safe to try to remove it by withdrawal upwards. It might have been assumed that the plate could have been drawn downwards if the stomach had been opened and forceps introduced into the œsophagus from below, but this is a blind method by which any untoward complication like perforation or hæmorrhage could not be properly dealt with. Of course, it must be remembered that the œsophagoscope can be used through a gastrotomy.

Though these considerations supported the decision to carry out thoracotomy, the question of the side to be employed arose. For operation for neoplasms of the œsophagus situated at about the site of impaction of the plate, the approach from the right side is much the better, as was urged by my old pupil, the late Laurence O'Shaughnessy (1934) and further emphasized by the experience of my senior assistant, R H Franklin (1942). But, confronted with the problem of a foreign body which had been so long impacted, there was the haunting fear of involvement of the aorta, and it was felt that any complication thus arising could be so much better dealt with under the guidance of the eye from the left-sided approach.

The question of preliminary gastrostomy had to be reviewed, but I did not think of adopting this measure in the case under consideration because the patient was at least able to swallow liquids and semi-solid food without much difficulty and was consequently in reasonably good condition. But it would have been quite a sound plan to make a gastrostomy had it been necessary to improve the nutrition, and, at the same time, it would have sufficed to solve the feeding difficulties and anxieties after operation and it would also lessen the infective factor by diversion of septic particles from the site. It would have the further value that the incised and sutured area of the œsophagus would be protected from strain during healing. Though it would not have been wrong to make a preliminary gastrostomy even without such indications, I had sufficient confidence in the healing properties of the œsophageal wall to feel that it could be dispensed with. Of course, gastrostomy could very readily have been carried out as a last step in the operation of removal if called for by unexpected circumstances, such as the unusual friability of the œsophageal wall or uncertainty as to the efficiency of the suture line.

When considering the possible difficulties of the actual operation against which I felt one ought to be forearmed, the most serious concerned the relationship of the foreign body to the aorta. From clinical experience and a knowledge of pathological material and of the literature (Grey Turner, 1946), I knew only too well that there is a remarkable tendency for sharp objects to erode towards or into the aorta, and it occurred to me that during the process of removal that vessel might be damaged, possibly the last stages of an impending perforation being made actual. Should this occur I thought the safest plan would be rapidly to separate the aorta from the œsophagus and then endeavour to close any hole in that artery by direct suture. I have some little experience of this matter in cases where perforation of the aorta has occurred during an attempt at œsophagectomy. In such circumstances I have been able to arrest hæmorrhage successfully by drawing the edges of a small aperture together, using a sharp-pointed cleft-palate needle with fine catgut, such sutures of apposition being reinforced by an additional stitch or two in the adventitia. Any persisting oozing from the site might be controlled by the application of fibrin foam, although this material was not available on the occasions in which I had to suture the aorta. Recently surgeons have been fortified by the experience of

Professor Crafoord (1945), of Stockholm, who has taught us that the descending thoracic aorta can be compressed for as long as 20 to 25 minutes so that repair of that vessel may be more effectively carried out. With a ragged tear or friable tissue it might even be wise to excise a small section of part of the wall of the aorta in order to get clean fresh edges for suturing.

Another possible difficulty that occurred to me was laceration of the œsophageal wall occurring in the neighbourhood of the foreign body or friability at the suture line. I have actually seen the œsophagus torn completely across at the site of an ulcerating lesion. Probably even at the worst some sort of repair could be made, but it might not be very efficient. In these circumstances I pictured that it would be necessary to intubate the œsophagus and also to bring a tube from the immediate proximity of the sutured œsophagus out through the chest wall to make a track to the exterior in the event of leakage. The point at which the chest wall should be traversed admits of some little discussion. To bring the tube out immediately posterior suggests itself as the nearest and probably the best route, but in carrying this out there one is embarrassed by the aorta (Grey Turner, 1916). The next best thing would be to bring the tube out through the parietes at the anterior end of the intercostal incision, for in the sitting position which the patient would probably occupy after operation, this might prove to be the most dependent spot. If effective suture of the œsophagus turned out to be quite impracticable, then it would be essential to make a gastrostomy after the chest had been safely closed. As a direct consequence of inefficient suturing or of extra friability, a fistula might develop, but the presence of a drainage tube down to the site of repair would probably determine the safest and most convenient external site for the external opening to be situated. Among the complications to be borne in mind when the infected and friable œsophagus requires to be opened, mediastinitis comes first. If symptoms of this condition become apparent as judged by the very ill condition of the patient, together with tender swelling and possibly crepitant œdema at the root of the neck or air bubbles demonstrated in the mediastinum by X rays, then the position would already be very serious, but drainage and the use of penicillin might be sufficient to stave off impending disaster (Grey Turner, 1946). As a late sequel a stricture might develop, but that would probably be the least of the troubles because with such a very definite inflammatory origin its management would only be a question of the intelligent use of bougies.

Finally, it would be unwise to assume that the successful outcome of this case was entirely due to the use of penicillin and the other antiseptic adjuncts now available.

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# CAROTID BODY TUMOURS

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## CAROTID BODY TUMOURS

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BECAUSE of their rarity carotid body tumours are very seldom diagnosed before operation. When met with unexpectedly at operation they present difficult technical problems. Most of the full accounts of the condition have appeared in the American literature. Bevan and McCarthy collected 143 cases in 1929. Gratiot reviewed the subject in 1943 and found 253 cases reported in the literature. In this country Hutchinson first drew attention to "peculiar tumours" in the neck which he called "potato tumours", but he did not associate them with the carotid body. Gilford (1904), Stewart (1931), and Gordon-Taylor (1940) reported three, four, and five cases respectively.

with the patient at rest in a reclining position. A Grass, 3-channel ink-writing electro-encephalograph was used and bipolar recordings were taken from twelve symmetrically placed electrodes. Occasional low-voltage

### CASE REPORTS

**Case 1**—A woman, aged 23, had noticed a swelling on the right side of her neck for two years (Fig 440). This had gradually increased in size. She complained of frequent sore throats and occasional spontaneous fainting attacks. These had occurred on the average once a fortnight. On one occasion she had lost consciousness when the lump was accidentally touched.

**ON EXAMINATION**—A firm smooth swelling  $2\frac{1}{2} \times 2\frac{1}{2}$  in was found half in front of the right sternomastoid, half deep to it, at and above the level of the upper border of the thyroid cartilage. It was mobile from side to side, but not vertically, and showed definite transmitted pulsation. No murmur was present on auscultation. Pressure on the common carotid below the tumour caused the pulsation to cease and the tumour to shrink from  $2\frac{1}{2} \times 2\frac{1}{2}$  in to  $1\frac{1}{2} \times 2\frac{1}{2}$  in.

On pressure over the tumour the patient became pale and clammy within twenty seconds. Her respiration quickened and her eyes began to roll. She began to cry—without any cause, as she stated later—and her face twitched. Within a minute she had lost consciousness. The blood-pressure, which at rest was 130/75 mm Hg, fell to 80/60 mm Hg and quickly recovered on release.



FIG 440—Case 1. Photograph showing the swelling in the right side of the neck.

waves at 4-5 c/s appeared, but otherwise the record was within normal limits, showing a moderately sustained alpha rhythm at 10-12 c/s of about 40-50 microvolts. A right-sided anteroposterior electrode arrangement was then used, and the effects of compression were

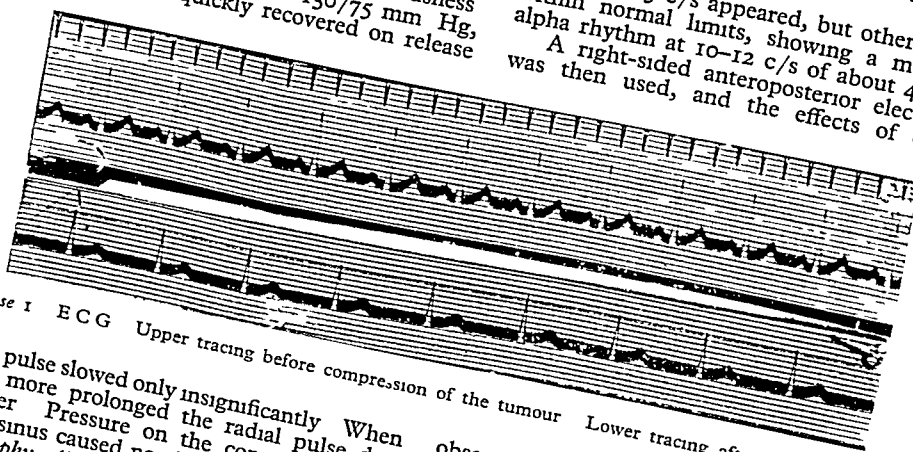


FIG 441—Case 1. ECG. Upper tracing before compression of the tumour. Lower tracing after 10 seconds compression.

of pressure. Her pulse slowed only insignificantly. When the pressure was more prolonged the radial pulse disappeared altogether. Pressure on the common carotid or the left carotid sinus caused no change.

**Electrocardiography** (Fig 441)—Sinus arrhythmia at a rate of 70/80. Pressure on the tumour has very little effect on the rate, but causes the P waves to disappear. This may indicate the onset of nodal rhythm.

**Electro-encephalography** (Fig 442) (Mrs J Turner)—routine EEG examination was first carried out

observed. Pressure on first the right and then the left carotid artery proximal to the tumour, and also on the left carotid sinus, showed no change in the EEG pattern.

Compression of the tumour showed a sudden appearance of widespread irregular high-voltage slow waves at 1-3 c/s after 17 seconds. Pressure was maintained for 45 seconds in all, and the slow waves persisted for a further 15 seconds after release, then ceased abruptly, the EEG pattern reverting to the resting picture.

Immediately prior to compression of the tumour the resting pulse-rate was 108, but three seconds before the onset of the slow waves it had fallen to 48. Towards the end of the discharge no pulse was palpable, but 10

from behind the angle of the jaw to the sternoclavicular joint, with a slight convexity forwards. The internal jugular vein had to be divided. The tumour was not unduly adherent to surrounding structures apart from

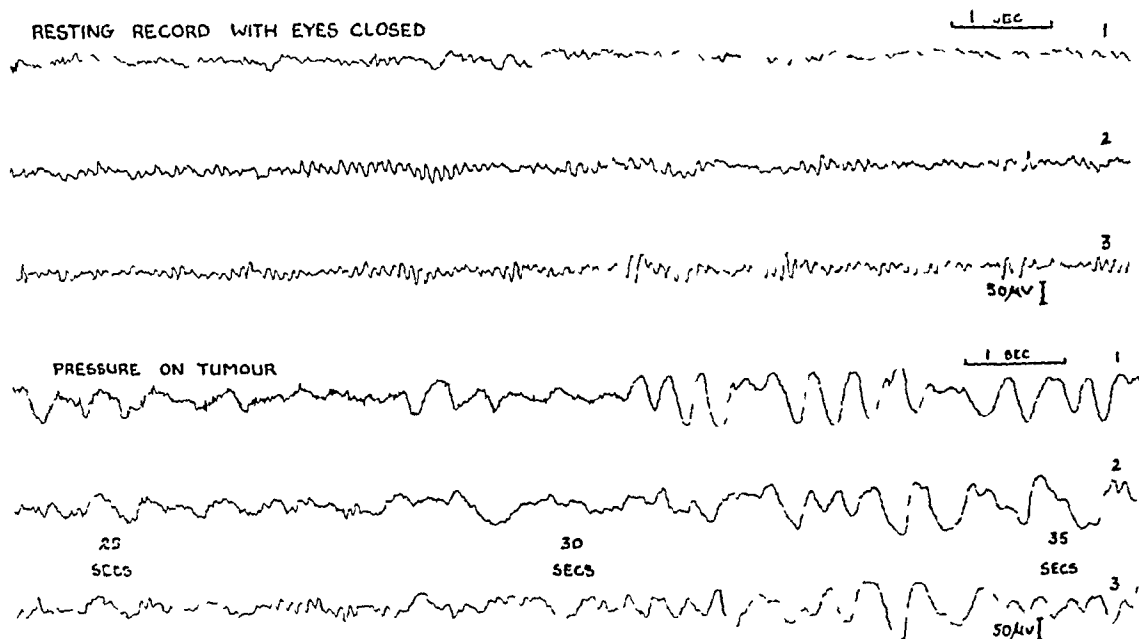
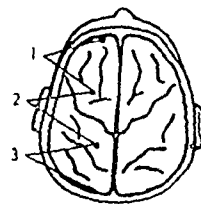


Fig 442—Case 1. Electroencephalographic records (see text)

seconds after the reappearance of the normal pattern it could just be felt. Twenty-five seconds after this the rate had risen to 120 per minute.

The experiment was repeated using a left-sided anteroposterior electrode arrangement and a similar result was obtained.

**BIOPSY**—On Dec 29, 1945, a biopsy was performed by Mr R L Newell through a transverse incision. The vascularity of the tumour was striking. No change in blood-pressure or pulse-rate were noted on compression of the tumour under the anaesthetic (gas, oxygen, ether)



where the previous biopsy had been performed. In trying to dissect the tumour off the common carotid, which was completely encircled by it, the vessel was opened and had to be tied.

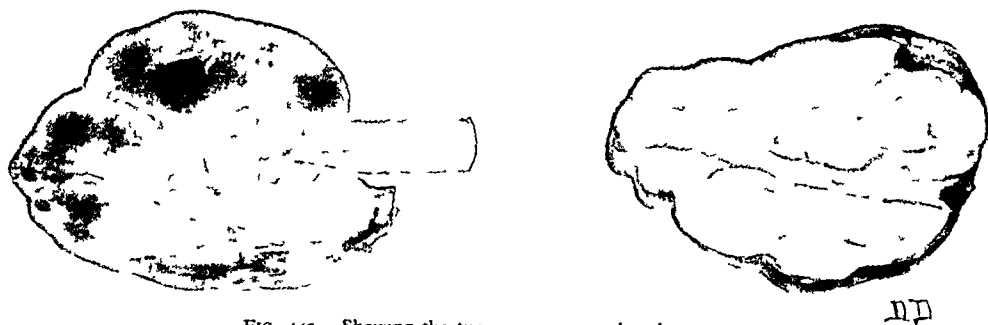


FIG 443—Showing the tumour as removed and in section

The right common carotid artery was compressed daily, at first for 5 minutes, increasing gradually to 35 minutes. No abnormal physical signs were detected in the nervous system after 35 minutes' compression.

**OPERATION** (Jan 31, 1946) (Mr R L Newell)—anaesthetic gas, oxygen, ether. The incision extended

The post-operative course was uneventful. No important nerves were damaged and no signs of cerebral anaemia were observed. Three months after operation the patient showed no ill effect from the carotid ligation and was able to carry out her normal occupation.

**PATHOLOGICAL REPORT** (by Dr J Davson, Victoria University, Manchester) —Macroscopically, the specimen consisted of a somewhat pear-shaped mass with an indistinctly lobulated outer surface, measuring 5 cm × 3.5 cm (Fig 443). It weighed 30 g. On section the

The stroma in some cases consists of acellular fibrous tissue, in other areas it is represented only by the flattened capillary spaces. A thin fibrous capsule is present. Stains for chromaffin substance were negative.  
**DIAGNOSIS** —Parathylioma of the carotid body



FIG 444—Case 1. A low-power view showing the typical glomerulus-like cell groups in the lower central field, while top centre the cells show an ill-defined trabecular arrangement. Haematoxylin and eosin ( $\times 30$ ).



FIG 445—Case 1. A higher magnification of a glomerulus-like body, separated from adjacent similar bodies by flattened vascular spaces. Some nuclei are vesicular in type, others are hyperchromatic. The cell cytoplasm is pale. Haematoxylin and eosin ( $\times 120$ ).



FIG 446—Case 1. A higher magnification of the trabecular type of cell arrangement, showing a predominance of hyperchromatic nuclei. The cell cytoplasm tends to be darker staining. Haematoxylin and eosin ( $\times 120$ ).

mass is of a fairly uniform whitish colour, with slaty blue and yellowish foci visible. The common carotid enters the tumour at the lower pole and divides into the internal and external carotid branches, which leave the tumour from its superior aspect.

**ON SECTION** (Figs 444–446) there is some variation in the histological appearance of the tumour, both in the arrangement of the cells and in their appearance. The characteristic cells have pale-staining round or oval nuclei with well-developed nuclear membrane and a coarse chromatin network. The cell outline is indistinct and polyhedral in shape, the cytoplasm is pale-staining and mainly granular. The cells are arranged characteristically in round compact masses about the size and shape of renal glomeruli and are separated by compressed vascular spaces lined by prominent capillary endothelial cells. In other areas the cells form much smaller groups and cords which are separated by a meshwork of capillaries lined by hypoplastic endothelium.

Elsewhere the cells have darker-staining oval or round nuclei and a more eosinophilic cytoplasm, and the arrangement is in somewhat irregular-shaped ill-defined cell masses.

**Case 2** —Mr M, aged 37, a lecturer in architecture, came under the care of Mr W R Douglas in June, 1940, complaining of a swelling in the left side of the neck of two years' duration. It was slightly sensitive to pressure and had varied in size. The patient gave a history of rheumatic fever at 18 and a winter cough for several years.

**ON EXAMINATION** —There was a mass deep and anterior to the left sternomastoid muscle at the level of the angle of the jaw. It was smooth, tender, not unduly fixed, and of firm consistency. The spleen was palpable  $\frac{1}{2}$  in. below the costal margin. The blood-pressure was 140/90 mm Hg, and the Wassermann reaction was negative. A pre-operative diagnosis of tuberculous lymph-glands was made.

**AT OPERATION** (July 4) (Mr W R Douglas) —Under avertin-gas-oxygen anaesthesia a vertical incision was made along the sternomastoid. The muscle was split and "a very vascular looking tumour lying behind the bifurcation of the carotid" was exposed. It was here that the true nature of the tumour was recognized. The vessels were closely adherent to the tumour and had to be ligated.

Next morning there was no paralysis. Thirty-six hours after operation, however, the right side of the face, the tongue, and the right arm were paralysed. Aphasia and dysphagia were marked. The right leg was unaffected. On the next day (July 7) some improvement was noticed and this continued until the patient was discharged on Aug 6, when only slight facial weakness remained. The blood-pressure on discharge was 125/80 mm Hg. A year later no residual weakness remained and the patient had returned to his previous occupation. He has been seen at regular intervals ever since and has been keeping in perfect health.

**HISTOLOGY** —The tumour cells are arranged partly in well-defined spherical masses separated by broad bands of acellular collagen, and partly in less well-defined groups separated by irregular spaces lined by endothelial cells.

The cells are of polygonal outline, with fairly eosinophilic cytoplasm. The nuclei are mainly hyperchromatic, predominantly oval, and occasional multinucleate forms are present. No definite mitoses were seen, but the cytological appearances are suspicious of a low-grade malignancy (Figs 447, 448).

**DIAGNOSIS** —Parathylioma of the carotid body

## DISCUSSION

**Historical**—The carotid body was first described by v Haller in 1743. In 1880 Riegner removed the first carotid body tumour. He ligated the common carotid artery. The patient developed hemiplegia and died on the third day. Maydl's case in 1886 was the first to survive. A temporary

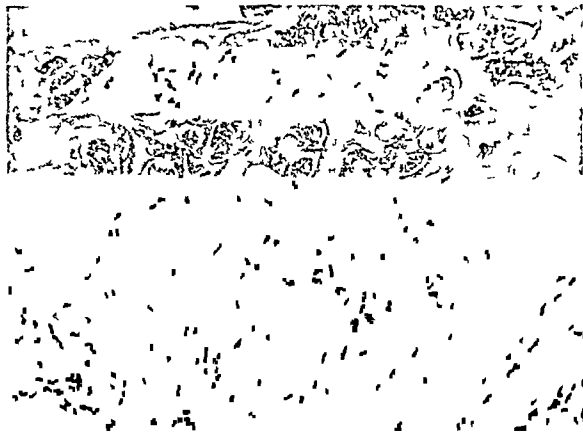


FIG 447—Case 2. A low power view showing the glomerulus like bodies separated by strands of hyaline fibrous tissue. The clear spaces surrounding the cell masses are the result of shrinkage. Hematoxylin and eosin ( $\times 30$ ).

on one side. The bodies increase in size up to the age of puberty and then slowly atrophy.

The carotid body is situated behind the common carotid artery at its bifurcation. It is reddish brown in colour, oval in shape, and measures up to 7 mm in its long axis. It is surrounded by a firm capsule which sends septa into its substance, subdividing it into lobules. The connective tissue is rich in

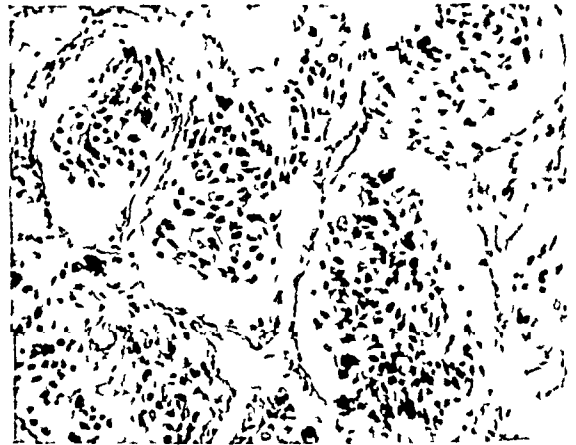


FIG 448—Case 2. A high power view showing the glomerulus like bodies in which the cell nuclei are all hyperchromatic and of somewhat irregular shape. Hematoxylin and eosin ( $\times 120$ ).

hemiplegia followed ligation of the arteries. The first removal without ligation was carried out by Albert in 1889.

**Embryology**—The origin of the carotid body is still under dispute. According to Kohn (1900) it develops from the sympatho-chromaffin cells, which later mature into chromaffin cells. The carotid body

medullated and non-medullated nerve-fibres. The lobuli consist of spherical masses of large polyhedral cells which contain large eccentrically placed and deep-staining nuclei. The cell membranes are often difficult to distinguish.

The vascular supply is usually derived from the external carotid artery via a small fibro-adipose

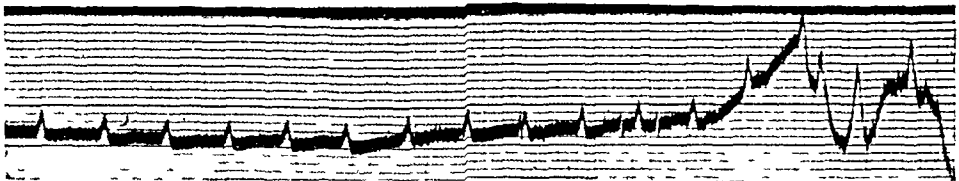


FIG 449—E C G in a case of carotid sinus syncope of the cardio-inhibitory type.

has therefore been classed into the chromaffin system, together with the suprarenal medulla and the aortic and coccygeal bodies. Kohn's view of the affinity of the cells of the carotid body to chromic salts has not been confirmed in the human, although it holds good with other species in which the carotid body contains a larger element of sympathetic ganglion cells. According to Maurer (1895) and Boyd (1937) the carotid body develops from the mesoderm of the third branchial arch and receives early connexions from the artery of the arch and the ectoderm of the glossopharyngeal nerve, which is the nerve to the third branchial arch. Elements from the sympathetic and vagus are incorporated at a later date.

**Anatomy**—The carotid body is inconstant in man. Funke (1904) found a carotid body in only one out of eight fetuses dissected, and that only

pedicle called the ligament of Mayer. The artery enters the lower pole and breaks up into branches, each of which enters a lobe and forms a dense capillary network around the cells. The veins form a plexus over the surface of the body, from which the blood is led away by several branches which drain into the superior laryngeal, lingual, and pharyngeal veins. The nerve-supply comes from the glossopharyngeal nerve, the pharyngeal branch of the vagus, and the superior cervical ganglion.

**Physiology**—Extirpation or absence of the carotid bodies has no adverse effect. Various functions have been assigned to them, but most theories have been disproved. De Castro (1928) was the first to suggest that they may act as chemoreceptors, and Dripps and Comroe (1944) have shown that they respond to chemical changes in the

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arterial blood, chiefly decreased oxygen tension and increase in acidity. These stimuli produce a rise of the respiratory and cardiac rates and in arterial blood-pressure, in addition to an increased activity of the cerebral cortex. This mechanism might suggest that the carotid body is derived from the gill cleft mechanism of fish, where it would act as a mediator between the oxygen tension of the water and the respiratory rate. This function of the carotid bodies might therefore be taken to support the theory of the embryological origin from the third branchial arch.

**Pathology**—Tumours constitute the only pathological lesion of the carotid body. About 265 cases have so far been reported. They are lobulated and, unless frankly malignant, well encapsulated. They are situated inside the carotid sheath at the level of the bifurcation. As they grow they encroach on the carotid region and may wedge themselves tightly between the mandible and the mastoid process. Inferiorly they may occasionally extend down to the clavicle.

They are slow-growing tumours, usually benign at first but they may become malignant later. The average length of the history in benign tumours is 4.5 years, that of malignant ones 8.9 years. Benign tumours have been removed after having been present for over twenty years. Some cases must have been malignant from the beginning. Peterson and Mecker (1936) report a case of a woman of 38 with a history of only ten months' duration from whom a malignant tumour was removed. The patient died nine months later of malignant cachexia. A large number of patients in their twenties reported with malignant tumours.

Malignant tumours invade the capsule and involve surrounding structures. Most rapid growth commonly occurs upwards, involving the base of the skull and later the brain. Lymph-gland metastases are rare and only one undoubted case with liver metastases has been reported (Lund, 1917). Two patients of the Mayo Clinic showed signs of possible brain secondaries.

In 50 per cent of cases the tumour completely surrounds the carotid vessels and is inseparable from them. Carotid body tumours are very vascular and have a plexus of veins on their surface, so that if operated upon under a wrong diagnosis the extreme vascularity, as well as their situation inside the carotid sheath at the level of the bifurcation, should correct this error.

**Histology**—The majority of tumours arise from the epithelial type of cell. Marchand (1891) and Paltauf (1892) believed that they originate from perithelial cells and suggested the term 'perithelioma'. Although this view has not been generally accepted this term has been widely employed, "as it recalls a prominent structural feature" (Ewing, 1940). A few tumours of nerve-cell origin have been reported (Gordon-Taylor, 1940; Good-sitt and Sudmack, 1945), which are usually described as neuroblastomata, neurofibromata, or ganglioneuromata.

The cells of the perithelioma are similar to those found in the normal carotid body. The cells often grow in syncytial masses. Where the membrane shows clearly, the cells are polyhedral in shape. The

nuclei are hyperchromatic and the protoplasm is granular. Their affinity to chromic salts is inconstant. The dye takes only very faintly if at all. According to de Castro (1928), the carotid body does not contain chromaffin cells.

Harrington, Claggett, and Dokerty (1941), from the Mayo Clinic, describe two patterns, which they call the alveolar and the peritheliomatous. In the alveolar pattern large islands of polyhedral cells are separated from each other by narrow bands of connective tissue. Large thin-walled vascular sinuses traverse the fibrous tissue and are often encroached upon by budding masses of tumour cells. In the peritheliomatous pattern the alveoli are smaller and more irregular. They are separated from each other by very vascular connective tissue. The cells are arranged in nests or irregular strands. Both our cases belong to this type.

Hyaline degeneration or cavity formation is often seen in the centre of the tumours. In malignant tumours the alveolar formation is lost and the cells grow diffusely throughout. The stroma may become sarcomatous.

**Aetiology**—Tumours of the carotid body occur with equal frequency in both sexes. Both sides are equally affected. Four bilateral cases have been reported (Lund, 1917; de Tarnovsky, 1932; Chase, 1933; Harrington, 1941). The average age is 43.2 years (Fig. 450).

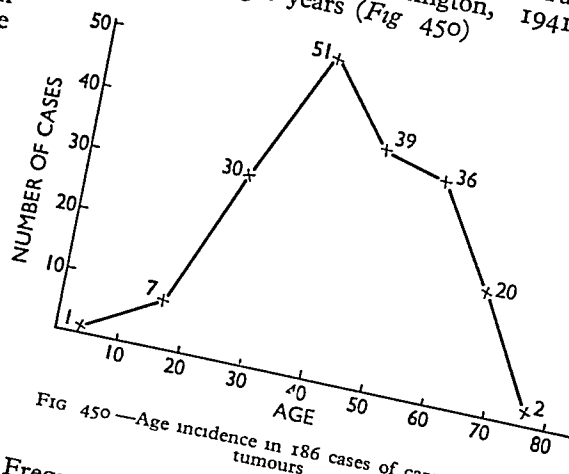


FIG. 450—Age incidence in 186 cases of carotid body tumours

Frequent sore throats are often mentioned in the history. The thyroid gland was enlarged in 3 cases (Nix).

**Symptomatology**—The most frequent history is that of a painless unilateral slow-growing tumour in the neck. The average duration before the patient consulted the doctor was seven years. Rarely the tumour is sensitive to touch, but it is never painful. Other symptoms are due to compression or invasion of surrounding structures. These are not frequently met with. Hoarseness, dyspnoea, dysphagia, cough, and tinnitus may be due to compression of the vagus. Horner's syndrome, due to pressure on the cervical sympathetic, and earache due to involvement of the cervical plexus, have been reported. Fainting attacks are due to the coexistence of a sensitive carotid sinus. Reid (1920) reported a lemon-yellow pigmentation of the skin in 2 cases which disappeared after operation.



**Carotid Sinus Syndrome**—Overactivity of the carotid sinus reflex has been associated with a carotid body tumour in 5 cases out of 260 found in the literature, and in *Case 1*. The incidence of their coexistence is too high to be purely accidental. The nerve-supply of the sinus is similar to that of the carotid body, being derived chiefly from the glossopharyngeal nerve by way of the carotid sinus nerve of Hering and probably also from the vagus, hypoglossal nerve, and the sympathetic. A tumour of the carotid body may therefore occasionally produce an overactive sinus by two mechanisms, either by direct pressure or by way of a reflex arc. Other lesions in the neighbourhood of the bifurcation of the common carotid, such as cervical, lymphadenopathies—chiefly tuberculous—are very occasionally associated with a hypersensitive sinus.

Carotid sinus syncope can be precipitated in subjects with a sensitive sinus by a sudden turning of the head, wearing tight collars, or by pressure over the sinus. It is characterized by pallor, hyperpnœa, muscular twitching, and dizziness, followed by unconsciousness. Flushing of the face occurs on recovery. Two types of carotid sinus syncope are recognized, depending on which of the two efferent pathways—the vagus or the vasomotor depressor nerves—predominates.

In the cardio-inhibitory type in which vagal cardiac inhibition is the predominant factor, a marked fall in blood-pressure is associated with complete asystole or ventricular standstill. The ECG during the attack shows no alteration of potential or only a succession of P waves (see *Fig. 449*). This reaction can often be prevented by atropine.

In the vasodepressor type vasodilatation causes a fall in blood-pressure and the consequent cerebral anæmia results in unconsciousness. The cardiac rate does not slow markedly and vagal stimulation of the heart produces at the most nodal escape, so that the ECG shows either no alteration from normal or absent P waves, as in *Case 1*. This type may often be relieved by sympathomimetic drugs such as ephedrine or benzedrine.

The EEG shows moderate- to high-voltage slow (delta) waves during unconsciousness. This is an unspecific response and can be seen in syncope from various causes such as venepuncture, distension of colon and rectum, etc (Engel, 1944).

A third type has been described in which syncope is unassociated with any significant alteration in blood-pressure or cardiac rate. This has been called the cerebral type, but its existence is doubtful.

Cure from carotid sinus syncope follows excision of local glands or tumours or follows denervation of the sinus if the hypersensitivity is due to arteriosclerosis, hypertension, or other general causes (Ray and Stewart). Cases of lesser severity are amenable to medical treatment.

**Physical Signs**—The tumours are ovoid or round in shape, situated at the bifurcation of the common carotid artery, lying partly under the sternomastoid, elevating the anterior border of that muscle, and partly in front of it. The surface is smooth or finely lobulated. The consistency is firm, resembling the texture of a fibrotic tuberculous gland. Lying within the carotid sheath, firmly

attached to the artery, they can be moved from side to side but not vertically. On account of their vascularity, they can be temporarily reduced by pressure. Compression of the common carotid artery also temporarily reduces their size. Transmitted pulsation can always be elicited. A few tumours present a bruit and thrill. A sensitive carotid sinus, if present on the same side as the tumour, will give rise to the typical attacks on pressure on the tumour for about 30 seconds. The pharyngeal wall is occasionally displaced by the tumour and physical signs due to pressure on surrounding nerves are found occasionally.

**Diagnosis**—The correct pre-operative diagnosis has only been made in 25 out of 180 tumours. The most common erroneous diagnoses are tuberculous glands, branchial cyst, aneurysm, or lateral aberrant thyroid tumour. Secondary malignant glands, branchial carcinoma, neurofibroma, lymph adenoma, and lymphosarcoma must also be considered. A punch biopsy has been suggested, but has been thought dangerous by most workers on account of the vascularity of the carotid body tumour. Even biopsy can be misleading, as reported by Walton (1946), where the section showed a typical carotid body tumour with islands of epithelioid cells separated by vascular stroma. A previous biopsy at another hospital and further investigation, however, showed this case to be a carcinoma of the arytenoid with secondary deposits in the cervical glands.

The criteria on which to base the diagnosis of carotid body tumours are—

- 1 A history extending over several years of a slow-growing painless tumour in the neck.
- 2 A firm oval tumour in the region of the bifurcation of the common carotid.
- 3 Free lateral but no or very limited vertical mobility.
- 4 Decrease in size on compression of the common carotid artery.
- 5 Transmitted but not expansile pulsation.

**Prognosis**—Prognosis depends on whether the common carotid has to be ligated and whether invasion has occurred before operation. The operative mortality is 15 per cent without ligation and 30 per cent when the artery has been tied.

Age and length of history are not a guide to whether malignancy has supervened. More rapid growth and horizontal fixation may be taken as an indication of malignancy. Usually it is only at operation when difficulty is encountered in shelling out that the invasive character of the tumour is manifest. Nor is age an infallible indication whether hemiplegia may occur after division of the common carotid. The youngest patient with a carotid body tumour in whom ligation of the common carotid resulted in hemiplegia was 26 years old. Pilcher and Tuss investigated 100 cases of hemiplegia after carotid ligation for various lesions. They did not find that age influenced the outcome of the operation.

**Treatment**—Radiotherapy does not appear to have any effect on carotid body tumours. Phelps and Snyder (1937) reported 7 cases treated without benefit by irradiation. Stewart (1931) and Birman (1924) reported one case each which did not respond to X rays. Gordon-Taylor's case (1940), in which

radiation was tried and failed, turned out to be of nerve-cell origin. The case reported cured by X rays by Bevan and McCarthy never had a biopsy done and does not seem to have been adequately followed up.

The ideal treatment is total removal of the tumour without carotid ligation. Gordon-Taylor makes a plea for conservation of the common carotids and states that with careful dissection the carotids can be saved in a much larger number of cases than hitherto. Gratiot (1943) points out that up to 1920, 82 per cent were ligated, whilst in the years 1928-37 this figure fell to 50 per cent and he thinks that even this could be improved.

Hemiplegia may come on immediately after operation when it is due to deficient collateral circulation of the cerebral hemisphere or it may be delayed for 24 hours or longer when, as Keegan (1933) pointed out, it may be due to ascending thrombosis occluding the middle cerebral artery. The hemiplegia may be permanent, but often it is only transitory, leaving very little final disability, as in Case 2.

An electro-encephalogram after compression of the common carotid for 30 to 60 minutes is the best indication of the competence of the collateral circulation, although it does not exclude the danger of delayed hemiplegia (Lambert Rogers, 1944). If the electro-encephalographic studies show a deficient collateral circulation and during the course of the operation it becomes obvious that the tumour is inseparable from the vessels, it may be wiser to abandon the operation and to rely on what little help X rays can give.

In order to lessen the incidence of hemiplegia manual carotid compression for periods up to 30 minutes for two to three weeks before operation has been advised. The efficiency of the procedure has not yet been proved. This could be done by a series of EEG studies. Mechanical devices to close the carotid gradually have been used a clamp (Halsted), and others.

**Operation**—A general anaesthetic has been used in most cases, as the operation tends to be a long one. The incision should be generous and should either run along the skin creases or along the anterior border of the sternomastoid. The platysma is divided as well and the flaps raised to beyond the borders of the tumour. The deep fascia is incised along the anterior border of the sternomastoid and the muscle retracted posteriorly. The carotid sheath is now opened below the tumour, the common carotid isolated, and a ligature put around it, but not tied. This is a safeguard in case the artery is torn during the dissection. The internal jugular vein is either stretched across the tumour or pushed backwards and is usually divided. The vagus and sympathetic lie behind the tumour in the carotid sheath and must be carefully preserved. The superior laryngeal nerve of the vagus may be divided if it gets in the way. The hypoglossal nerve should be kept out of harm's way as it runs forward medial to the upper pole of the tumour. The tumour is freed from surrounding structures on all sides. It

can be rotated from side to side to put all adherent structures on the stretch. An attempt should be made to dissect it off the arteries. If the vessels are not completely encircled this should be done by sharp dissection, but if they are completely surrounded Gratiot (1943) recommends inserting an artery forceps along the vessel from below and dividing the overlying tissues between clamps, much as one would separate the thyroid isthmus from the trachea. It is during this procedure that the vessel is most likely to be torn. If the vessel has to be tied it should be transfixed at the same time. The tumour can now be pulled upwards, exposing the vagus in its bed, and dissection proceeds from below upwards. The internal and external carotid arteries are then tied and transfixed and the tumour is removed. The skin and platysma are sutured, a small drain being left at the lower end of the wound. Following ligation of the common carotid the patient should be kept in the Trendelenburg position for 10 days and not allowed up for another 2 to 3 weeks (Schorstein, 1940). This minimizes the danger of cerebral anæmia, which is the most common post-operative complication, giving rise to hemiplegia, aphasia, facial palsy, and unconsciousness. Deviation of the tongue would follow hypoglossal injury, and vocal cord paralysis would follow damage to the recurrent laryngeal nerve.

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## THE SURGICAL TREATMENT OF HYDROCEPHALUS

### A SIMPLE METHOD OF PERFORMING THIRD VENTRICULOSTOMY

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METHODS of performing third ventriculostomy which involve open craniotomy, such as those described by Dandy (1935) and by Stookey and Scarff (1936), seem rather severe in infancy, and are not free from unpleasant sequelæ. It is hoped, therefore, that the description of a simple and apparently safe method of performing third ventriculostomy (floor of the ventricle) will be of use to surgeons who, in the past, have hesitated to use more formidable procedures. Briefly, the method is to puncture the floor of the third ventricle by means of a hollow needle passed from above into a lateral ventricle, directed through the foramen of Monro into the third ventricle by touch or by telescope, and advanced to its destination under the X-ray screen.

In the past, third ventriculostomy has been reserved for cases of non-communicating hydrocephalus. The division of hydrocephalus into communicating and non-communicating types is an arbitrary one, and has been overemphasized. Two cases are reported to show that there are also types of communicating hydrocephalus which respond to third ventriculostomy.

This communication must be regarded as in the nature of a preliminary report, because the number of cases treated is small, and because no case has been followed for more than three years.

#### THE CAUSE OF HYDROCEPHALUS

Cerebrospinal fluid is formed by the choroid plexuses, leaves the ventricular system by the foramina of Luschka and of Magendie, to reach the subarachnoid space, where it is absorbed. Some fluid is absorbed in the spinal subarachnoid space, but most must pass forward through the basal cisterns and their branches to reach the cerebral subarachnoid space. Any obstruction in the main fluid pathways, inside or outside the ventricular system, results in hydrocephalus if the degree of obstruction is sufficient to interfere with the free flow of cerebrospinal fluid, and so cause the pressure in the ventricles (behind the obstruction) to be higher than the pressure in the cerebral subarachnoid space (beyond the obstruction).

The most complete obstructions are probably incompatible with survival for more than a few days. Fulminating hydrocephalus of this kind occasionally follows operation on a lumbar meningocele. Hydrocephalus which pursues a more leisurely course is probably due to a partial obstruction, the degree of which is roughly proportional to the rate of progress of the disease.

The degree of obstruction does not always remain constant. Hydrocephalus sometimes progresses with increasing rapidity, as though the hydrocephalus, by distortion, were aggravating the primary obstruction. Probably a more common cause of swift deterioration is the development of a secondary obstruction, by compression of the main subarachnoid

pathway at the level of the incisura tentorii (Cairns, 1939).

#### THE RATIONALE OF THIRD VENTRICULOSTOMY

If, then, hydrocephalus is due to an obstruction in the main fluid pathways, and such an obstruction can always be demonstrated at autopsy (Dandy, 1935), the rational treatment is to remove, or to by-pass, the block. In congenital hydrocephalus a direct attack upon the obstruction is seldom indicated. It is impossible in some cases, too hazardous in others, and in a third group direct intervention is followed by recurrence. Ventriculostomy is simply an attempt to by-pass the obstruction. As Dandy (1935) pointed out, the ideal spot for draining the ventricles into a cistern is just behind the pituitary stalk, in the floor of the third ventricle. An opening made here, even a small one, has a good chance of being permanent, because of the thinness of the floor, relative absence of neuroglia, and the depth of the cistern beneath.

Cauterization of the choroid plexus, as practised by Scarff (1936), Dandy (1938), Sachs (1942), and Putnam (1943), seems to be wrong in principle. As long as the block remains, the pressure in the ventricle will be higher than the pressure in the cerebral subarachnoid space, and the ventricles will continue to expand. A reduction in the volume of cerebrospinal fluid formed may retard the rate of expansion, but seems unlikely to effect a complete cure. Surely, too, apart from the immediate risk of operation, there is the considerable danger that floating particles from the operation will be carried to the site of obstruction, will lodge there, and will cause an acute, perhaps fatal, exacerbation of the condition.

#### HYDROCEPHALUS ASSOCIATED WITH LUMBAR MENINGOMYELOCELE

The regular association of the Arnold-Chiari malformation with lumbar meningocele was pointed out by Russell and Donald (1935). Hydrocephalus when it occurs (it frequently follows operation on the lumbar sac), is usually communicating in type, the block being in the subarachnoid space around the brain-stem at the foramen magnum. The probable explanation is that the spinal cord, firmly fixed in the lumbar region, is elongated by the growth of the spinal column, and so draws part of the brain, including the foramina of Luschka and of Magendie, into the spinal canal. In a severe case brain elements may be found as low as the seventh cervical vertebra. Operation on the lumbar region may precipitate matters by the sudden release of cerebrospinal fluid or by traction on nervous elements attached to the sac. All cases must be regarded as being potentially hydrocephalic.

Many cases of meningocele should not be subjected to operation. If there is no hydrocephalus, no increase in the size of the sac, and no immediate danger of ulceration or rupture of the sac, they are best left alone. Many cases are too severe. For example, it is hardly justifiable to operate when there is complete paralysis of lower limbs and of sphincters. No improvement in the paralysis can be expected to follow operation.

For cases in which operation is contemplated, the following programme is suggested —

- 1 If hydrocephalus is already present it should be treated first, by third ventriculostomy
- 2 Before opening the lumbar sac, pressure should be released from above, by tapping a lateral ventricle
- 3 If a general anaesthetic is used a perfect airway must be maintained
- 4 The table should be tilted steeply, head down
- 5 There must be no traction on cord or coverings
- 6 If hydrocephalus develops after operation in spite of these precautions, third ventriculostomy should be performed

D'Errico (1938) has performed an extensive cervical laminectomy for the relief of hydrocephalus in these cases, with some success. Third ventriculostomy appears to be simpler and safer (*Case 2, Fig 451*), though a bone operation may be indicated later for the relief of other symptoms



FIG 451 — *Case 2*. Sacral meningocele causing paralysis of sacral nerves and associated with hydrocephalus of mild degree. The hydrocephalus responded to third ventriculostomy.

### DIAGNOSIS OF CONGENITAL HYDROCEPHALUS

The advanced case may be diagnosed by inspection, but a certain diagnosis cannot be made in the early case merely on the grounds of enlargement of the head, with large, tense, or bulging fontanelle. A number of such cases will be found on ventricular puncture and ventriculography to have no enlargement of the ventricles. Some alleged spontaneous cures may be in cases of this type. In all doubtful cases, and these will include the majority if an early diagnosis is to be made, the lateral ventricle should

be punctured through the anterior fontanelle. The scalp is punctured obliquely, and a fine-bore needle is used to minimize the risk of subsequent leakage. Usually the cortex is thinned to a remarkable degree, and the ventricle is entered soon after puncturing the dura. If the diagnosis is still in doubt, a volume of fluid is withdrawn from the ventricle, a considerably smaller volume of air is injected, the exchange being made gradually, and radiographs are taken.

### INVESTIGATION

It has been customary to divide hydrocephalus into communicating and non-communicating types. In the first there is free communication between the ventricles and the spinal subarachnoid space. In the second there is not. Whatever tests are used care should be taken not to make unwarranted assumptions from them.

Phenolsulphonaphthalein injection, recommended by Dandy (1935), has proved satisfactory in our hands. Our procedure is as follows —

- 1 Preliminary tap of a lateral ventricle to relieve the pressure above the obstruction. Possibly some ill effects attributed by others to phenolsulphonaphthalein are due to neglect of this precaution.
- 2 Lumbar puncture is performed, and  $\frac{1}{2}$  c.c. of phenolsulphonaphthalein solution is injected. More than  $\frac{1}{2}$  c.c. may be used if the head is large.
- 3 After 20 minutes the ventricle is tapped again and the colour of the fluid is noted.

*a* An intense colour means that there is free communication between the ventricular system and the spinal subarachnoid space (communicating type). The obstruction is in the fluid pathways outside the ventricular system, but this does not mean that the interpeduncular cistern beneath the floor of the third ventricle is obliterated. The block will frequently be behind this point, and so relief will follow third ventriculostomy. There is no way to determine the patency of the interpeduncular cistern prior to operation.

*b* If no dye has reached the ventricle in 20 minutes the hydrocephalus is said to be non-communicating. Relief should follow third ventriculostomy.

4 In non-communicating cases Dandy (1935) recommended that the rate of dye excretion in the urine be measured. The urine collected in two hours is alkalized if necessary, and the volume compared with the volume of  $\frac{1}{2}$  c.c. of dye diluted to match. If the quantity of dye appearing in the urine approaches 40 per cent of the quantity injected, there must be free communication between spinal and cerebral subarachnoid spaces and a normal rate of absorption.

Dandy thought that the excretion of less than 10 per cent of the dye indicated an obstruction of the subarachnoid pathways in addition to a ventricular block, and was a contra-indication to third ventriculostomy. However, this subarachnoid component, when it exists, is probably only secondary. Hydrocephalus may cause a secondary compression of the subarachnoid pathways at the incisura tentorii or at the foramen magnum. If the primary obstruction can be short-circuited, one would expect the secondary component to be relieved also. The dual nature of the obstruction in some cases of hydrocephalus

has been emphasized by Cairns (1939) Two of our non-communicating cases showed a poor dye excretion, in one case due to a low output of urine Both showed a satisfactory dye excretion when the test was repeated, and both responded to third ventriculostomy

### INDICATIONS FOR THIRD VENTRICULOSTOMY

**1 Congenital hydrocephalus** Whatever the type of hydrocephalus, if any treatment is to be carried out, third ventriculostomy by the method to be described appears to be the treatment of choice It may fail to relieve some cases of communicating hydrocephalus, but this by itself is no bar to the use of a procedure attended by so little risk

There is no point in operating on the advanced case (although it is remarkable how long the faculties are preserved) or on the case with evidence of other intracranial defect If operation is to be performed, the sooner it is done the better If for any reason operation is delayed, the head should be kept at a reasonable tension by ventricular taps Any large quantity of fluid thus obtained is best re-injected subcutaneously to prevent dehydration and demineralization

**2 Acquired hydrocephalus** Both post-meningitic hydrocephalus and benign stricture of the aqueduct of Sylvius appear to be suitable for third ventriculostomy No case of the latter has yet been treated by us Space-occupying lesions causing hydrocephalus are usually subjected to direct attack However, when a tumour is inoperable, third ventriculostomy may sometimes be considered as a palliative

### THE OPERATION

#### **1 Preliminaries —**

*a* A burr hole must be made in older patients, but this step is unnecessary in infants when the site of needle puncture falls within the anterior fontanelle

*b* Enough fluid is removed from a lateral ventricle to reduce the tension to a reasonable level This reduces leakage at operation, and tends to deepen the interpeduncular cistern If the case is one of non-communicating hydrocephalus, 10 or 15 c.c. of the ventricular fluid is mixed with 1 c.c. phenol-sulphonaphthalein, and is re-injected by lumbar puncture This procedure will further deepen the interpeduncular cistern, and will colour the fluid it contains

*c* The patient is transferred to the X-ray screening room, where apparatus has been assembled for both postero-anterior and lateral screening Metal markers are attached to the skin in the midline over the glabella and over the inion, and on either side above and in front of the ear, and as close as possible to it The midline markers must be placed with great accuracy If there is any doubt about the position of the inion, or if there is asymmetry of the head, a radiograph to show the foramen magnum is taken as a check Patient and X-ray equipment are then arranged as for operation, and a lateral radiograph is taken to show the position of the sella turcica in relation to the lateral markers (*Fig 452*) The markers need not be accurately superimposed on the film, but their position on the film must be

exactly reproduced on the fluorescent screen at operation

**2 Anaesthetic**—For infants a general (non-inflammable) anaesthetic is the most reliable Our



*FIG 452*—Lateral radiograph taken immediately before operation At operation, after the needle has entered the third ventricle, the radiologist uses these markers as a guide to the sella turcica

preference is for a little trilene administered on an open mask For older patients local anaesthetic is used

**3 Instruments**—A 19-gauge hollow needle of sufficient length The point must be ground right off and the end rounded, the stylet must fit loosely so that it may be removed from the needle without a jerk

#### **4 Present Method —**

*a* A tenotome puncture is made through scalp and dura, preferably on the right side, 1–1½ in from the midline, depending on the size of the head, and 1–1½ in behind the coronal plane which passes through the temporomandibular joints The hollow needle is passed through this puncture and on into the lateral ventricle The needle must not be gripped or hindered in any way by scalp or dura

*b* The needle is advanced towards the floor of the anterior horn a centimetre or two in front of the foramen of Monro by directing the needle slightly towards the midline and a little in front of a line joining the temporomandibular joints As the floor of the ventricle is approached, the needle is halted once or twice, and the needle point is moved from side to side to touch the side-walls of the ventricle By this manoeuvre the side-walls are easily avoided, and the needle point is carried safely to the floor of the ventricle

*c* The operator then feels his way posteriorly, tapping along the floor of the anterior horn, like a blind man with his stick, until the needle falls into the third ventricle The lining of the lateral ventricle is resistant enough to a blunt needle for this to be done quite easily and safely

*d* The needle is moved gently from side to side to feel the sides of the foramen of Monro, then, with the needle centred in the foramen, the point is

advanced to puncture the floor of the third ventricle. The operator takes both hands from the needle and steps back.

*e* The radiologist screens the head postero-anteriorly and laterally. In determining the position of the needle he relies on the metal markers. During lateral screening the head must be moved until the lateral markers occupy exactly the same position on the fluorescent screen as they did on the lateral film. Usually the needle is found to have reached the right spot or to be within a millimetre or two of it. If the radiologist thinks that the position of the needle can be improved, lights are turned on while the operator withdraws the point into the third ventricle, and punctures the floor again. Screening is repeated to determine the new position. Rarely will a third puncture be found necessary.

*f* In non-communicating cases the stylet is withdrawn. A flow of coloured fluid confirms that the point lies in the interpeduncular cistern.

helped us to become familiar with the interior of the hydrocephalic lateral ventricle, but, in the end, proved to be unnecessary.

When the foramen of Monro is large (in a boy of 14 years it appeared to be enormous), it is possible to pass a telescope right into the third ventricle as Mixer (1923) did. We have not attempted to do this in the living. We feel that the methods described above are easier, safer, and more generally applicable.

### POST-OPERATIVE COURSE

Early crises have sometimes followed other types of operation and have been attributed by some to the sudden reduction of intracranial pressure. We have not observed any post-operative upset of any kind. The usual course of events in infants is that the bones of the vault fall together and engage during the first 24 hours, thereafter the anterior fontanelle, now reduced in size, becomes deeply concave during the



A



B

FIG 453—Case 1. A, Anterior fontanelle outlined the day before operation. B, 2 days after operation. There is extreme depression of the fontanelle. 110 c.c. of fluid was injected into a lateral ventricle without completely relieving the depression. A small dressing shows where the needle was introduced at operation.

*g* The needle is removed. The point is not agitated before withdrawal. Simple puncture probably provides an adequate and permanent opening. Any wide movement of the needle point is dangerous.

*h* A suture is placed in the scalp to prevent leakage and a collodion dressing is applied.

### EARLIER METHOD

In the first four cases treated the needle was passed through the foramen of Monro under vision. A telescope was introduced into the lateral ventricle through a separate puncture placed far enough lateral to the needle puncture to allow the two instruments to be manipulated independently. The foramen of Monro was at once identified by the choroid plexus, which enters the foramen from behind, the needle was passed through the foramen, and the telescope was withdrawn. Subsequent steps were the same as those given above.

**Comment**—The only disadvantage of the earlier method was that two punctures of the cortex had to be made instead of one. The telescope

next two or three days (Fig 453), then the concavity slowly disappears, and is gone by the end of the first week. Possibly the choroid plexuses take some days to recover from the effects of prolonged intraventricular pressure, and to reach their normal secreting capacity. Extreme depression of the fontanelle should be relieved, to protect cerebral blood-vessels, by injecting fluid into a lateral ventricle (Case 1). Hartmann's solution is suitable for this purpose.

The escape of fluid from ventricle to subarachnoid space through the punctures made in the cortex may be discounted as a factor in producing improvement, because no benefit has ever followed simple punctures of the cortex up to 3 mm diameter (telescope size), although such punctures of a thinned-out cortex remain patent for many weeks.

Puncture of the floor of the third ventricle might be expected to produce some disturbance of the autonomic nervous system. In practice this has not occurred. There has been no unpleasant sequel of any kind.

## RESULTS

## NON-COMMUNICATING HYDROCEPHALUS

Four cases have been treated. All were markedly relieved by operation. The first case treated was a female infant with a severe degree of obstruction (*Fig 454*). She has now been followed for three years. Development, behaviour, and intelligence all appear to be normal. The circumference of the head has increased by less than  $\frac{1}{4}$  in. in the last six months.

Two other infants with severe hydrocephalus have been treated. One died of an unrelated acute respiratory infection two months after operation.



A

## CASE REPORTS

*Case 1*—C K, female aged 12 months, with communicating hydrocephalus of moderate severity.

**HISTORY**—Enlargement of the head was noticed at 2 months. For the last six months she had been in an institution on a diet of cow's milk. No solid food had been added. She was generally retarded, but recently she had shown some interest in toys, and had attempted to raise herself by grasping the sides of the cot.

**ON EXAMINATION**—She was apathetic and overweight. Two teeth had erupted. The circumference of the head was 22 in. The shape of the head and the outline of the anterior fontanelle are shown in *Fig 453*. It was thought her backwardness was partly due to diet and environment.



B

**FIG 454**—Non-communicating hydrocephalus. A, Encephalogram before operation with head right side up, showing air in the subarachnoid space, none in the ventricles. B, Encephalogram one month after operation, with head right side up. Air freely enters the ventricular system. This case has been followed three years.

The other, now followed for nine months, is progressing most satisfactorily.

The fourth case, a boy of 14 years, said to have had meningitis at the age of 2 years, was treated because of increasing spasticity. It was feared that he would soon become bedridden unless something was done. The head circumference was 27 in. Symptomatic improvement after operation was beyond expectation. Twitching and vomiting ceased, spasticity was greatly improved. There has been no relapse in one year.

## COMMUNICATING HYDROCEPHALUS

Three cases have been treated. The first case was unrelieved. It is possible that failure in this case was due to a technical error. The puncture may have been made away from the midline because of gross asymmetry of the head. Unfortunately there was no radiographic check of the position of the midline markers, nor was the operation repeated. There was no autopsy.

The other two cases, one due to the Arnold-Chiari malformation, were treated recently. Nevertheless, they seem to be worth reporting, because it has been widely assumed that communicating hydrocephalus will not respond to third ventriculostomy.

**OPERATION** (Nov 24, 1945)—No telescope was used. A small dressing shows where the needle was introduced (*Fig 453, B*). Two days later, depression of the anterior fontanelle was extreme (*Fig 453, B*). The scalp was sharply drawn in over the fontanelle margins. The floor of the depression was tight and rigid, it did not pulsate, and it moved only slightly when the infant cried. There were no symptoms apart from slight drowsiness, but it was felt that thin-walled blood-vessels might give way if the intracranial pressure were not raised. Accordingly, 110 c.c. of Tyrode's solution (Hartmann's solution was not available) was allowed to run into a lateral ventricle. Even this did not entirely relieve the depression of the fontanelle. During the next two days the fontanelle was again deeply indrawn, but not quite to the same extent. No more fluid was injected. The concavity had disappeared by the eighth day. Now, after five weeks, the infant is happy, bright, and responsive. Part of the improvement is due, of course, to a change of diet and to more personal attention.

*Case 2*—M T, female aged 7 years. Mild degree of hydrocephalus, associated with sacral meningocele (*Fig 451*).

**HISTORY**—She was admitted to an institution when she was a few weeks old. The head has slowly increased in size, but the sacral sac and the paralysis of legs and sphincters, so far as anyone knew, had not altered. She had never been out of bed.

ON EXAMINATION—She was a friendly, happy, and attractive child of normal development and nutrition. She was mentally retarded, but less so than one would expect as a result of her confined existence. The head circumference was  $24\frac{1}{2}$  in., but, apart from enlargement of the head, hydrocephalus appeared to cause no symptom, nor was there any evidence of brain-stem compression. The upper limbs were normal. Over the upper part of the sacrum was a tough, thick-walled sac, which measured  $2\frac{1}{2}$  in. in diameter. There were bed-sores 2 in. in diameter over the ischial tuberosities. Structures supplied by sacral nerves showed almost complete paralysis, but the thigh muscles were strong, and easily able to support the body-weight. There was a little fixed flexion of hips and knees. It was thought that she could be made to walk, and that orthopaedic treatment would be well worth while if the hydrocephalus could be arrested. There was no indication to interfere with the sac in the sacral region.

OPERATION (Dec 1, 1945)—Operation was performed under local anaesthetic, without using a telescope. In the days following operation, changes in cerebrospinal fluid pressure, although less marked than in *Case 1*, were clearly reflected in the size and tension of the sacral sac, which became smaller, softer, and more wrinkled. Changes in size were recorded by taking plaster casts of the sac. During the month since operation her vocabulary and general knowledge have increased enormously, and she has learned to walk with the aid of a walking frame.

### SUMMARY

1 A simple and apparently safe method of performing third ventriculostomy (floor of the ventricle) by means of a hollow needle introduced from above by way of the lateral ventricle, foramen of Monro, and third ventricle is described.

2 It is hoped that the method will be of use to surgeons who, in the past, have hesitated to use more formidable procedures.

3 In the past, third ventriculostomy has been reserved for cases of non-communicating hydrocephalus.

4 The division of hydrocephalus into communicating and non-communicating types is an arbitrary one, and has been over-emphasized. Two cases are reported to show that there are also types of communicating hydrocephalus which respond to third ventriculostomy.

5 Cauterization of the choroid plexus seems to be wrong in principle. Also floating debris after operation must sometimes aggravate the hydrocephalus.

6 Suggestions are made for the prevention and treatment of the type of hydrocephalus associated with lumbar meningocele.

I am greatly indebted to Dr N F C Hill for all the radiological work, and to Dr Murray A Falconer for helpful advice in preparing this paper.

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## CEREBRAL THROMBO-ANGIITIS OBLITERANS

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UNTIL recent years thrombo-angitis obliterans was known as a disease affecting primarily the peripheral blood-vessels of the extremities. From the publications of Barron and Linenthal (1929), Perla (1925), Cserna (1926), and others, and especially the examination of autopsy material by Jaeger (1932), it became known that the vessels of the heart, kidneys, stomach, and pancreas are often similarly affected. It was found that the disease might start in visceral vessels and not involve the periphery at all, or that it might affect the peripheral and central vessels simultaneously. Gresser (1932) and Marchesani (1934) described a similar process in the vessels of the retina.

Cerebral symptoms associated with peripheral thrombo-angitis obliterans have been reported occasionally in the literature during the past ten years. In a study of 500 cases of peripheral thrombo-angitis obliterans Hausner and Allen (1938) found the evidence of a cerebral lesion in 11, or 2 per cent, of the cases.

The purely cerebral form as first observed and described by Foerster and Guttmann (1933) and studied anatomically by Spatz (1935) and later by

Bielschowski (1936), Stender (1936), Benedek (1936), Lindenberg (1939), Rosenhagen (1939), Antoni (1941), and others, presents many diagnostic difficulties. It has been diagnosed frequently as lues, juvenile arteriosclerosis, hypertension, atypical multiple sclerosis, or an intracranial tumour. The condition is not as rare as might be expected and may very well be responsible for many organic cerebral changes which are not clearly diagnosed and which masquerade under the name of other diseases. Symptoms of increased intracranial pressure are rarely present and often the symptoms are only those of a localized cortical process. In many instances intermittent claudication follows the initial cerebral symptoms and may aid in making an accurate diagnosis. In the cases of true cerebral thrombo-angitis obliterans reported in the literature a diagnosis of cortical atrophy due to a vascular lesion was made in a few instances following encephalography or ventriculography. The air studies showed a unilateral or bilateral enlargement of the lateral ventricles and enlarged subarachnoid spaces over one or both hemispheres. Obliterated cerebral arteries have been described by Sorgo (1939) and



Sunder-Plassmann (1941) in arteriograms of patients with Buerger's disease. However, the majority of the reported cases were diagnosed at autopsy.

Cerebral thrombo-angitis obliterans occurs most commonly in people between the ages of 30 and 50 years. The course of the disease is chronic and progressive, but frequently presents sudden attacks of temporary symptoms and complete remissions.



FIG 455—Operative exposure of the right fronto-parietal region (Case 1). The thin, white, string like obliterated vessels are seen branching off from normal larger vessels. The cortex below the obliterated vessels is pale, yellow, and atrophic.

The symptoms depend upon the location and the extension of the diseased vessels and for this reason they can be numerous and widespread. The most common are headaches, paræsthesias, pareses, aphasia, and visual defects. Convulsive seizures may be observed and psychic and memory changes are frequently present. In the following 11 cases a diagnosis of a localized cerebral lesion was made. The symptoms were those of an intracranial space-occupying lesion but it was not possible to rule out a vascular lesion. The clinical pictures pointed to definite localizations and the severity and progression of the symptoms justified a craniotomy in 9 of the cases.

### CASE REPORTS

**Case 1**—A 34-year-old female had a history of gradual onset of clumsiness and paræsthesia in the left hand following a fall while ski-ing. After four weeks' duration this condition gradually disappeared, and she was free of symptoms for ten months. She then suddenly developed a paralysis of the left leg which was followed by a convulsive seizure involving the entire left side of the body. Paræsthesias, weakness, and clumsiness of the left upper extremity soon developed. The neurological examination performed a few days later revealed a slight left facial weakness and a paresis of the left upper extremity most marked in the hand. The paralysis of the left leg had entirely disappeared. Subjective hyperæsthesia of the left upper extremity, impairment of joint and vibratory sense in the fingers of the left hand, a marked loss of stereognosis in the left hand as well as a marked clumsiness were present. Rapidly alternating movements, finger-to-nose and finger-to-finger tests were poorly done with the left hand, and all the deep reflexes were hyperactive on the left side. Her blood-pressure was 120/70 and her serology negative. A diagnosis of a right fronto-parietal lesion was made, and at operation an extensive

yellowish and atrophic area was found posterior to the central sulcus, through which ran obliterated cortical vessels appearing like thick white threads (Fig 455). The patient was put on bromide therapy and had no convulsions until 20 months later, four weeks before the normal delivery of a healthy baby. She has been well since (18 months), although she has temporary periods of depression.

**Case 2**—A 38-year-old male gave a history of numerous attacks of temporary paræsthesia, clumsiness, and paresis of the left extremities and the left side of the face over a period of eight years. More frequent and severe attacks associated with increased weakness of the left arm and hand, speech disturbances, memory defects, and inability to concentrate had occurred in the four weeks immediately preceding hospital entrance. At examination there was a marked muscular weakness of the left forearm, hand, and fingers involving especially the flexor groups. An objective hyperæsthesia of the distal phalanges as well as a subjective hyperæsthesia over the entire left upper extremity and the left side of the face was present. Stereognosis was slightly diminished in the left hand. The finger-to-finger and finger-to-nose tests and rapidly alternating movements were poorly performed with the left hand. All of the deep reflexes were hyperactive on the left side. Words were clearly but slowly spoken and the patient stated that he had to picture the written words in his mind before pronouncing them. His memory for recent events was poor and he had difficulty with simple arithmetic problems. He often cried and laughed out of proportion to the stimulus and usually without reason. His blood-pressure was 120/80 and the serology negative. A diagnosis of a right temporo-parietal lesion was made, and at operation a thickened arachnoid and numerous obliterated cortical vessels were found over the right parietal and temporal lobes with neighbouring areas of atrophy and softening (Fig 456). Three and a half years after the operation he has occasional attacks of tingling in the left arm, hand, and foot and is facetious, but is working regularly.



FIG 456—Operative exposure of the right fronto-parietal region (Case 2), showing disseminated white and obliterated vessels over granular appearing cortex.

**Case 3**—A 47-year-old male gave a one-year history of severe and progressive paræsthesias in both his right extremities. During the three months before examination he developed a right hemiparesis and transitory speech disturbances. At examination the movements of the right hand were slow and awkward and alternate movements were performed clumsily with the right fingers and hand. The deep reflexes were all hyperactive on the right side. His speech was slow and measured.

and he had difficulty in enunciating some of his words. At the time of examination the paresis of the right leg had receded almost completely. His blood-pressure was 150/80 and the blood serology negative. A diagnosis of a tumour of the left parietal lobe was made and an osteoplastic craniotomy performed. Over the motor and post-central regions numerous small, disseminated areas of yellowish degenerated and atrophied cortex were found, through which ran thin, white, completely obliterated vessels. Over the neighbouring normal-appearing areas the small cortical vessels were greatly increased in number and the arachnoid was thickened. The patient died 17 days following the operation of a bronchopneumonia of the right lung. At autopsy, sections of the brain and superficial cerebral vessels revealed inflammatory changes in the vessel walls. Few polymorphonuclears but many lymphocytes and a large number of young fibroblasts were present in the intima and the subintimal layers of the vessels. The lumen of the vessels was completely filled with large organizing thrombi. This picture was found in sections through vessels in various areas of the cerebral cortex. Engorgement of the capillaries, inflammatory changes around their wall, and glial proliferation were also present.

**Case 4**—A 53-year-old male gave a history of pain and weakness in the lower part of his back for eight years. During the 15 months prior to his hospital admission he developed a paraplegia which was followed by paralysis of the left upper extremity and urinary incontinence. At examination he was unable to sit or walk, the left upper extremity was completely paralysed, and both lower extremities showed a spastic paresis which was more marked on the left. Superficial and deep sensation was critically diminished over the entire left side and only slightly over the right lower extremity. All of the deep reflexes were hyperactive in the lower extremities and pathological plantar reflexes were present. The deep reflexes of the left upper extremity were also hyperactive. There were a left homonymous hemianopsia, a moderate degree of dysarthria, and sphincter disturbances. The patient was disorientated and showed numerous mental and psychic changes. His blood-pressure was 170/110 and the serology negative. A diagnosis of an intracranial lesion in the parasagittal area was made and a right osteoplastic craniotomy performed. When the dural flap was raised the entire exposed area showed a yellowish, soft, degenerated cortex with white obliterated vessels running in the deepened sulci. The patient died 36 days after the operation.

**Case 5**—A 62-year-old man had gradually progressing symptoms of weakness and spasticity in the right upper extremity and speech difficulties. At examination his speech was slow and hesitant and he had some trouble in finding words. When reading, words were skipped and others put together. He presented a right facial weakness and weakness, clumsiness, and astereognosis in the right hand. He had no objective disturbances of superficial sensations. The deep reflexes were more active in the right than in the left upper extremity. The blood-pressure was 160/80 and the serology negative. A diagnosis of a left fronto-parietal tumour was made and an osteoplastic craniotomy performed. The arachnoid was thick, opaque, and distended with fluid, and cortical atrophy was present. The cortex was yellow and atrophic in the precentral region and in the surrounding gyri the number of the cortical vessels was increased as if there had been an attempt to establish a collateral circulation. Over the atrophied areas several thin, white, and string-like obliterated arteries were present (Fig 457). Following the operation, the patient developed convulsive seizures which were controlled by bromide therapy. One year later the patient had some weakness in the right arm and leg and was emotionally disturbed by his progressive speech defect.

**Case 6**—A 37-year-old woman developed six months before her admission in the hospital a sudden transitory loss of vision and later a slowly progressive left visual defect. She suffered from frequent headaches and then developed paræsthesias and weakness in the left upper extremity. Examination revealed a left homonymous hemianopsia, a weakness in the left side of the face, and increased deep reflexes in the left extremities. Ventriculography showed the ventricles to be within normal limits.

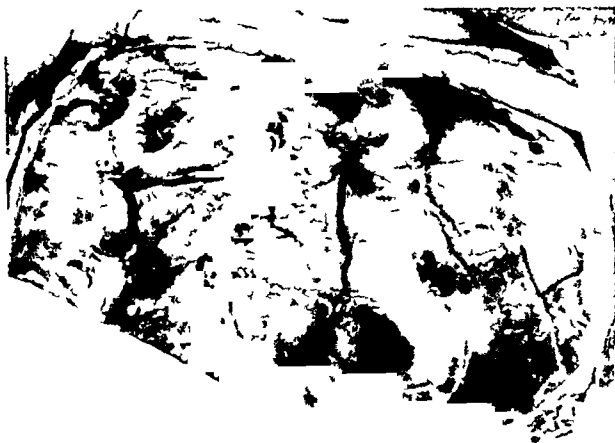


FIG. 457—Operative exposure of the left fronto-parietal region (Case 5), showing disseminated white and obliterated vessels, areas of cortical atrophy, and evidence of old perivascular inflammation involving the arachnoid.

Following this procedure she developed a transitory right homonymous hemianopsia. Her blood-pressure was 125/85 and the serology was negative. A right temporal lesion was diagnosed. An osteoplastic craniotomy was performed and a thickened arachnoid, obliterated cortical vessels, and atrophied gyri found. Nine months after the operation the patient still had the left homonymous hemianopsia and occasional attacks of paræsthesia in both hands.

**Case 7**—A 42-year-old woman had a four-year history of temporary diplopia, blurring of vision, and reading difficulty. Two years previous to hospital admission she developed sudden paræsthesias in the left arm and shoulder and was completely aphasic for a few hours. She also had personality difficulties and domestic problems which she was not interested in solving. One year later she developed recurrent temporary periods of numbness over the left side of the head, face, neck, and left upper extremity, with speech difficulties. One month prior to her admission in the hospital she had severe headaches, associated with nausea and marked reading difficulties. On examination she had a right incomplete homonymous hemianopsia, a complete alexia but could spell out individual letters, hesitancy in speech, and some weakness in the left upper extremity. The skin of all the extremities appeared mottled and was usually cold. The ulnar, radial, posterior tibial, and dorsalis pedis pulsations were palpable. The blood-pressure was 160/95 and the serology negative. Oscillometric readings were diminished in both feet and hands, but about equally. Immersion of the hands in warm water diminished the skin temperature in both lower extremities and produced pain in both hands and arms. Ventriculography disclosed equally dilated ventricles with large subarachnoid spaces and evidence of bilateral cortical atrophy. A pre-operative diagnosis of thrombo-angitis obliterans was made in view of the transient and bilateral symptoms and the ventriculographic findings. An osteoplastic craniotomy revealed a thickened arachnoid, a large subarachnoid space with atrophic gyri, and many small,

white, pipe-stem, completely obliterated arteries scattered over the frontal and parietal cortex. She was sent to a dry, warm climate and her condition had somewhat improved six months after the operation.

**Case 8**—A 50-year-old woman presented a seven-year history of nocturnal, convulsive seizures, associated in recent months with headaches, visual disturbances, and cold extremities. On examination she showed some clumsiness in the left hand and several thin white obliterated vessels could be observed on the left retina with signs of periangitis. Her blood-pressure was 150/90 and the serology negative. Encephalographic studies revealed symmetrically dilated ventricles with enlarged subarachnoid spaces, especially in both frontal areas. A diagnosis of cerebral thrombo-angitis obliterans was made and the patient put on anticonvulsant therapy. She later had an episode of marked mental disturbances which cleared up completely. She is working and complains of cold extremities and has an occasional nocturnal convulsion.

**Case 9**—A 63-year-old man had developed at the age of 62 transient paræsthesias in the left 4th and 5th fingers with progressive inability in performing movements with the left hand, progressive weakness and numbness in the entire left upper extremity, and later clumsiness in the left foot and weakness in the entire left lower extremity. Examination revealed a left homonymous hemianopsia, weakness and ataxia in the left upper and lower extremities, and hyperæsthesia in the left upper extremity. The finger-to-finger and finger-to-nose tests were poorly performed with the left hand. There was no loss of vibratory or joint sensation, but he had an astereognosis in the left hand. The deep reflexes were hyperactive on the left side and he had a left Babinski sign. The blood-pressure was 140/80 and the serology negative. A diagnosis of a right temporal neoplasm was made and at operation large subarachnoid spaces were found with areas of granular atrophy of the cortex and the presence of numerous white, obliterated vessels. The patient developed a bronchopneumonia and died on the fifth post-operative day. Unfortunately, an autopsy was not granted.

**Case 10**—A 52-year-old Jewish man gave a three-weeks' history of paræsthesias in the entire left lower extremity with attacks of anæsthesia accompanied by convulsive movements. He also had occasional paræsthesia in the left upper extremity. Examination revealed no muscular weakness or sensory disturbances. The deep reflexes were equal and there were no pathological reflexes. His blood-pressure was 120/86 and the blood serology was negative. Good pulsations were felt in all palpable arteries. Plethysmographic and oscillometric studies failed to show any abnormalities or differences between the right and left extremities. Skin temperature studies were within normal limits and showed a definite rise following immersion of the hands in hot water, but no drop following immersion of the hands in ice water. Ventriculography was performed and no deformity, defect, or displacement of the ventricular system significant of a space-occupying lesion could be seen, but it was not conclusive evidence. At operation the arachnoid was found distended with fluid, especially over the motor and premotor areas, it was also somewhat thickened, especially along the course of the vessels. The gyrus immediately posterior to the Rolandic vein and near the sagittal sinus was yellow and showed evidence of granular atrophy. Small, white, obliterated arteries were present in that area, together with a thrombosed vein. The patient was put on an anticonvulsant therapy. Two months after discharge from the hospital the patient was well and had had no recurrence of his attacks.

**Case 11**—This 53-year-old man presented a six weeks' history of numbness in the left side of his face and tongue,

followed later by clumsiness in the left fingers which progressed to a complete paralysis involving the entire left upper extremity. This paralysis cleared up to some extent, but numbness and weakness appeared in the left foot. The hyperalgesia disappeared in the face, but rather suddenly the entire lower extremity became completely paralysed. When admitted in the hospital he had a spastic left hemiparesis with complete paralysis of the lower extremity. There was an analgesia over the left extremities. Vibratory and position senses were absent in the left toes and fingers and there was a complete astereognosis in the left hand. The deep reflexes were hyperactive on the left side and he had a left Babinski sign. While in the hospital he developed convulsive movements which involved the left lower extremity. His blood-pressure was 138/76 and the blood serology negative. The pulse of the dorsalis pedis and the posterior tibial arteries was absent on the left side and the left foot was colder than the right. The left radial pulse was very weak and it was not possible to take a blood-pressure reading on the left arm.

Additional history revealed that for several years preceding his actual symptoms he noticed tiredness and pain in the calves when walking and he had to rest frequently. The capillaries in the nail-beds showed many abnormal forms and there was almost a complete stasis even after immersion of the hands in hot water. Plethysmographic studies showed greatly diminished pulsations in both the right and left fingers with only slight increase after immersion in hot water. Oscillometric tracings were greatly diminished in both legs and arms, but more so on the left side. Encephalography revealed dilated ventricles, the right being larger than the left, and symmetrically enlarged subarachnoid spaces. A diagnosis of cerebral and peripheral thrombo-angitis obliterans was made. The patient died of a collapsed left lung following extirpation of the right stellate ganglion in an attempt to dilate his cerebral vessels.

Autopsy revealed atrophy of both hemispheres with granular appearing gyri in the frontal, parietal, and temporal areas, especially on the right side. Numerous small, white, obliterated, distal arteries were seen in these areas and the arachnoid around these vessels appeared opaque and thickened. The major portions of the anterior, medial, and posterior cerebral arteries and their main branches were normal and delicate in appearance. The circle of Willis showed no abnormalities or evidence of sclerosis. The left internal carotid artery, however, was completely obliterated in its bony canal, but there was no gross evidence of atherosclerosis. Obliteration of the left axillary and iliac arteries was also found. Microscopically they showed an enormous endothelial proliferation in the subintimal layer, with complete obliteration of the intima and the lumen of the vessel. The media and the externa were intact and showed no calcium or other atheromatous deposits.

## DISCUSSION

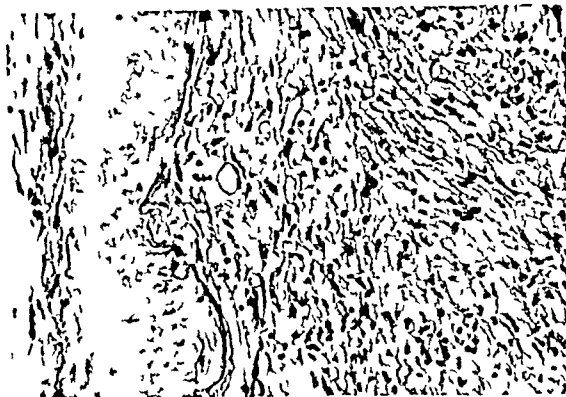
In 9 of the 11 cases with a similar clinical picture an osteoplastic craniotomy was performed. The dura mater was loose and baggy, the arachnoid thickened and opaque, and the subarachnoid space distended with cerebrospinal fluid. There were no signs of increased intracranial pressure. The distal portion of many of the smaller pial arteries in the exposed area of the brain was white and obliterated for a distance of one to two centimetres. Proximal to these portions of complete obliteration, the vessels were normal in size and appearance and contained liquid blood. These changes were observed in many of the distal branches of the middle cerebral artery scattered over the frontal, parietal, and temporal lobes. The appearance of the obliterated

vessels was that of worm-like white strings. Most of the vessels involved were arteries, but more rarely similar changes were found in veins. As Spatz (1935) and Lindenberg (1939) have shown, this process remains localized in one hemisphere or may be distributed symmetrically over both hemispheres in the border zone formed by the distal branches of the anterior, middle, and posterior cerebral arteries.

Disseminated cortical areas were found in various degrees and stages of yellowish discoloration, softening, and atrophy. There the gyri were small and granular and the sulci enlarged and deepened.

numerous small foci of softening with areas of glial proliferation which acted like a contracting scar. Similar macroscopical and microscopical changes were described by Spatz (1935), Lindenberg (1939), Luers (1942), Antoni (1941), Scheinker (1937), and others in reports on cerebral thrombo-angitis obliterans.

The anatomical diagnosis is made by the presence of the characteristic small, white, worm-like obliterated vessels, the granular atrophy of the cortex, and the presence of thrombi associated with proliferation of the endothelial cells of the intimal and subintimal



FIGS 458, 459.—Microphotographs of cross- and longitudinal sections of an obliterated vessel removed at operation. They show proliferation of the endothelial cells of the intima and complete obliteration of the lumen of the vessel. The elastica and the media are normal.

Smaller areas of softening were also present in gyri which had not undergone atrophy. These areas of granular atrophy and necrosis lay in the field of distribution of the obliterated vessels. Adjacent areas of cortex contained an increased number of capillaries and small vessels which gave the appearance of an attempt to establish a collateral circulation.

Cross- and longitudinal sections of obliterated vessels removed at operation showed a marked proliferation of the endothelial cells of the intima and the subintimal layers, with little or no changes in the media and the adventitia (Figs 458, 459). In some instances the media was narrower than normal. Large thrombi in various stages of organization completely obliterated the lumen of the vessels and were fixed to the vessel wall at the site of the roughest endothelial proliferation. They were well-organized and made up of loosely connected cells which contained in their meshes rests of pigment, newly proliferated small vessels, some histiocytes and a few small cells resembling lymphocytes. There were no fresh perivascular infiltrations in our sections as described by some authors in early stages of the disease. Spatz (1935) and others saw leucocytic and lymphocytic infiltrations in the thrombus, the adventitia of the vessels, and also in the subarachnoid space surrounding them in freshly diseased vessels. In the vessels which we removed at the time of operation no fresh inflammatory reactions were visible. However, in our cases studied at autopsy there were fresh inflammatory reactions in the intima of obliterated vessels and also around the wall of capillaries in areas of fresh cortical necrosis. The areas of granular atrophy showed the presence of

layers of the vessels. It is easily differentiated from arteriosclerosis which usually attacks larger vessels and is characterized by local deposits of yellowish concretions in the vessel wall, usually the media, and which produce an enlargement of the vessel. Thrombo-angitis obliterans involves, for the most part, the smaller arteries of the convexity, while arteriosclerosis has a predilection for the larger basal vessels and the proximal portions of the cerebral arteries. Hines and Barker (1940) have described an arteriosclerosis obliterans which they characterize by a hyalinization of the media with areas of fibrosis, calcification, and deposits of cholesterol and lipoids in the vessel wall, which thus occludes the lumen. Emboli from an endocarditis usually produce metastatic foci of encephalitis. Luetic endarteritis and periarteritis nodosa are also accompanied by marked inflammatory reactions which are more marked in the media and the adventitia of the vessel. The granular atrophy is secondary to numerous miliary areas of necrosis which result from the deficient circulation. Obliteration of one internal carotid artery is occasionally seen in connexion with cerebral thrombo-angitis obliterans and has been described by Sorgo (1939), Antoni (1941), and Sunder-Plassmann (1941). It is considered to be the result of secondary thromboses similar to the obstructions found in the brachial or femoral artery in cases of advanced peripheral thrombo-angitis obliterans.

The clinical diagnosis is more difficult. Most symptoms are transient in the beginning, come in attacks, and recede completely. They become permanent only in later stages of the disease. They

began in most of our cases with sensory disturbances, which were at first subjective and became later more objective. They usually involved only one side. The sensory symptoms were followed by weakness and a transitory paresis, which later became permanent. Except for one case which developed a paraplegia, the symptoms remained hemiplegic in type. Visual disturbances were present in 6 cases,

extremity. Personality and memory disturbances were observed in 5 patients. Of the 11 patients 7 were males and 4 were females and their ages ranged from 34 to 63 years. The blood-pressure was somewhat increased in 3 patients and all had negative serologic reactions in the blood.

Thrombo-angitis obliterans was diagnosed in 3 cases, in one the fundoscopic examination revealed

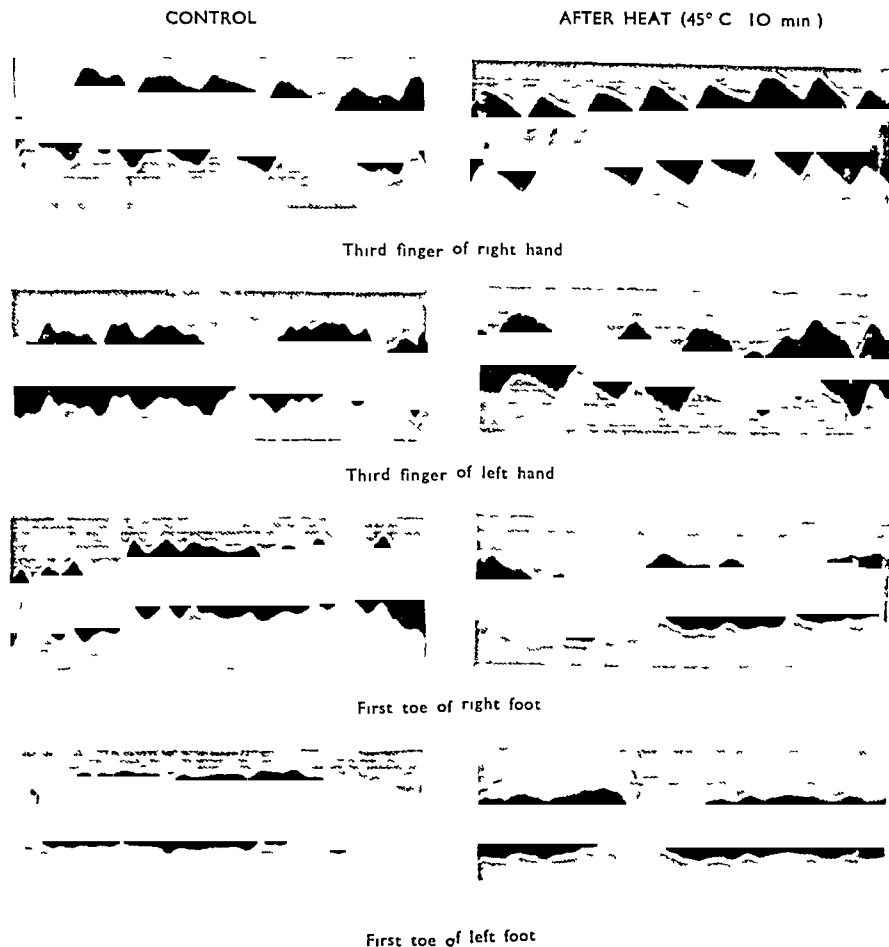


FIG. 460.—Plethysmographic tracings obtained from Case 3, showing a normal response after immersion of the patient's upper extremities in warm water for ten minutes, but no obvious increase in the amplitude of pulse volume in the lower extremities after immersion in warm water.

they were first noticed by the patient as transient disturbances and were occasionally associated with headaches of a migraine type. In 4 they resulted in a permanent homonymous hemianopsia. Speech disturbances were also common, they occurred in 6 patients, but remained incomplete and transient. In 3 of the patients the speech disturbance was associated with left-sided sensory and motor symptoms which pointed to the involvement of both cerebral hemispheres in the disease. This is made quite evident by the symptoms of the fourth patient, who had a severe paraplegia. Disturbance of stereognosis was present in 3 patients, 2 of whom otherwise had only slight sensory changes. Three patients had convulsive seizures which were generalized and associated with loss of consciousness and in 2 others the convulsions were localized in one

the presence of several arteries which were small, white, and obliterated in their distal portion. In another patient (Case 7) there were vascular changes in the skin, her extremities appeared mottled and were usually cold. The third patient (Case 11) had a history of intermittent claudication, and had obstructive vascular signs in two of his extremities. In the other 10 cases, however, the pulses of the radial, posterior tibial, and dorsalis pedis arteries were palpable and strong. None of the patients complained of disturbances in other organs, such as the heart, kidneys, and stomach, or of symptoms which could be interpreted as 'intermittent claudication of internal organs'. Air studies were performed in only 6 patients. In 3 the encephalograms showed definite evidence of cerebral atrophy with enlargement of the ventricular system and of the subarachnoid spaces.

which ruled out a space-occupying lesion. In Cases 3, 4, and 10 the ventriculograms were not conclusive, the ventricles were slightly larger than normal and the cerebral atrophy was not outstanding. Sunder-Plassmann (1941) and Sörgo (1939) have pointed out the changes produced by cerebral thrombo-angitis obliterans in arteriograms of the intracerebral vessels and think that this procedure is of some value especially in the diagnosis of advanced cases in which air studies are not conclusive. Arteriography was not performed in any of our cases.

Plethysmographic and oscillometric studies, which may show peripheral circulatory disturbances, were done in 3 cases. They failed to show any abnormalities in 2 cases in which there was no clinical evidence of peripheral Buerger's disease (Fig 460). In Case 11 the changes were significant of a marked circulatory disturbance in all the extremities and helped in the diagnosis. The same was true of the microscopical study of the capillaries and the skin temperature changes following immersion of the hands in hot and ice water. However, the signs and symptoms of the other 10 patients pointed exclusively to a cerebral lesion and their slow progression suggested in most cases a space-occupying lesion.

The clinical diagnosis of cerebral thrombo-angitis obliterans rests upon the long duration of transient but progressive symptoms, evidence of cerebral atrophy in pneumo-encephalograms, and possible peripheral vascular changes to be seen in the eye-grounds, in plethysmographic and oscillometric studies, or under the capillary microscope. It is true that in most cases peripheral vascular disturbances are not present and many of the latter tests will not be helpful in the diagnosis. The long duration of the symptoms and their transient character in the early stage of the disease suggest a circulatory disturbance, in these cases pneumo-encephalograms should always be done, and if they show the presence of dilated ventricles, unilateral or bilateral, without displacement, deformity, or defects, and evidence of enlarged subarachnoid spaces over the cerebral cortex, a space-occupying lesion may be ruled out and the diagnosis of a cerebral circulatory disorder can be made.

The aetiology and pathogenesis of cerebral thrombo-angitis obliterans are the same as those of the peripheral forms. Abuse of nicotine, trauma, exposure to cold, and non-specific infections have been held responsible for the disease, but this could only be possible on the basis of a pathological vascular constitution. Roessle (1938) includes thrombo-angitis obliterans with periarteritis nodosa in the group of the rheumatic vascular inflammations and thinks that the blood-vessel changes are part of a generalized allergic reaction. It is not definitely known whether the endothelial damage of the intima or the thrombus formation is the primary process, although it seems probable that a lesion of the intima exists prior to the formation of the thrombus. Most authors believe that the endothelial lesion causes a necrosis in the intimal and subintimal layers and results in the proliferation of endothelial cells upon which the thrombus forms. It is conceivable that the primary lesion may be the result of angiospasm since they have been observed in the retinal vessels by Marchesani and others. The

anatomically proven changes cannot explain all the clinical disturbances. Many of the transient symptoms must be produced by temporary circulatory disturbances which cause only slight and reversible cerebral damage. Temporary decompensation of the collateral circulation and variations in the blood-pressure and in the amount of circulating blood may be held responsible for many of the inconstant symptoms.

Vasodilator, antispasmodic, and anticoagulant drugs have not been used successfully, but improvements have been described following repeated intravenous injections of saline solution. Foerster (1933) and Sunder-Plassmann (1941) found marked improvement in the general condition and cerebral symptoms of 6 patients following the resection of both cervical sympathetic chains, and recommend it as treatment for cerebral thrombo-angitis obliterans. Sunder-Plassmann examined histologically the resected sympathetic ganglia and described marked degenerative changes of the ganglion cells. These may, however, be the result of the operative trauma and are far from conclusive evidence.

### SUMMARY

Eleven cases of cerebral thrombo-angitis obliterans are presented with symptoms and signs similar to those produced by a slowly growing intracranial tumour. Only 3 patients had evidence of peripheral circulatory disturbances. The history is usually of long duration and characterized by predominantly unilateral, early transient, but progressive symptoms which result in permanent damage. Nine cases were verified at operation and the microscopical examination of some of the obliterated vessels removed showed changes typical of this disease. Necrosis and granular atrophy of the brain result from the deficiency in circulation. The clinical diagnosis rests upon the inconstant character of the symptoms, the evidence of cerebral atrophy in pneumo-encephalograms, and peripheral vascular changes.

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## SHORT NOTES OF RARE OR OBSCURE CASES

SUPERNUMERARY BURSA OF PECTINEUS MUSCLE SIMULATING  
HERNIA IN INGUINAL REGION\*

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A HERNIA in the inguinal region may be simulated by many pathological conditions requiring differential diagnosis. One of these conditions which has not received much attention is the development of bursæ in this region. These bursæ generally occur in patients who have had a rather strenuous occupation which may have subjected this area to repeated trauma. The following case is a typical example

for a number of years. There was no definite history of any injury to the groin.

ON EXAMINATION—Regional examination revealed a mass about the size of a hen's egg subjacent to the medial half of the right inguinal ligament. It was round, firm, and slightly tender. There was no definite impulse on coughing, and it could not be reduced. It faintly transilluminated light. Examination revealed no connexion with the inguinal canal or the joint capsule

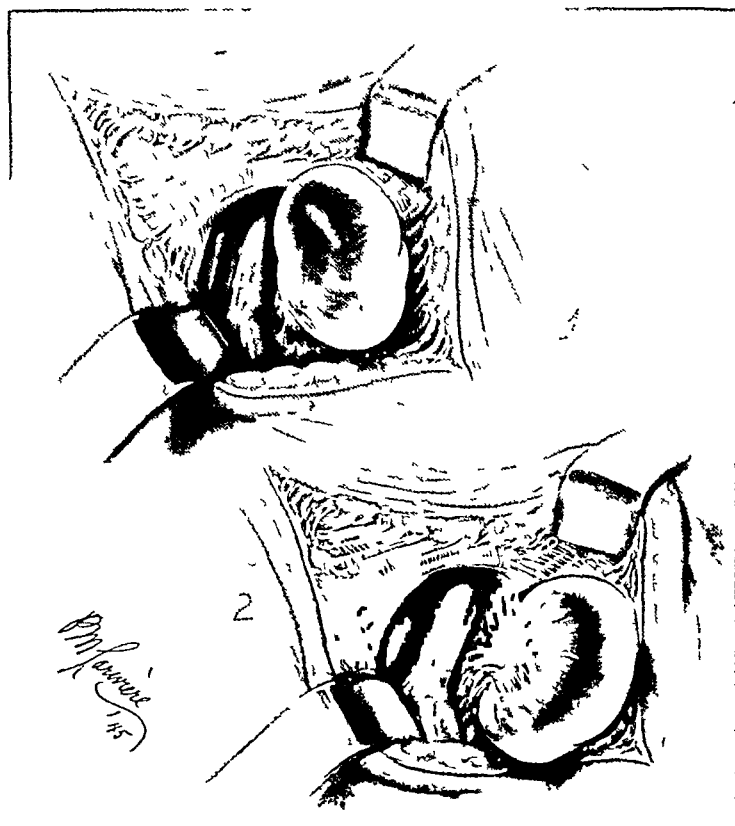


FIG. 461—A supernumerary bursa of the pectineus muscle, medial to the femoral vessels, simulating a hernia in the inguino femoral region.

## CASE REPORT

HISTORY—Mr O G, a referred case of 55 years of age, presented himself for "a hernia operation". He complained of a "rupture" in the right groin. He was a professional dancer and had practised acrobatic dancing

History revealed that it had gradually increased in size during the past two years. There was no regional lymphadenopathy. The patient had large external and internal hæmorrhoids. These were removed at the same time as operation on the groin.

AT OPERATION—Since it was not thought to be a hernia, an incision was made inferior to the inguinal ligament over the mass. A large encapsulated cystic tumour was found which was firmly fixed to the fascia of the pectineus muscle subjacent to the inguinal ligament.

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† Cooper Grant for Medical Research.



to the medial side of the femoral vein, and its capsule was adherent to several small branches of the long saphenous vein. Its gross appearance was that of a large ganglion of the type associated with tendon-sheaths (*Fig 461*)

#### THE SPECIMEN —

**Gross** The specimen consisted of an oval cystic structure measuring  $3.5 \times 2.5 \times 2.5$  cm. It was thin-walled, the external surface being covered with a small amount of fibrous connective tissue and fatty tissue. A fatty and fibrous tissue was adherent to the point where the wall was thicker than elsewhere. It contained clear watery fluid. There was a small daughter cyst measuring 0.5 cm in diameter.

**Microscopical** Section of the cyst wall showed it to be composed of a thin layer of collagenous connective tissue lined with a single layer of cuboidal cells. The cytoplasm of the cells was pale pink, the nucleus a dark purple. The connective tissue showed two lymphoid follicles, one of which showed a germinal centre.

### DISCUSSION

Especially in a 'referred' case of possible hernia in the inguinal region, the pre-operative examination should include three things —

- 1 Determine if a hernia actually does exist. Type it if possible.
- 2 Determine always if there is more than one hernia present.
- 3 Determine the nature of associated regional pathology (a) with, or (b) without a hernia.

**Cases for Differential Diagnosis** — Out of the past 100 cases examined for hernia, several interesting conditions have been revealed. One woman had a cyst of the round ligament simulating a hernia. One man of 68 years of age had a direct inguinal hernia, but with a regional lymphadenopathy which turned out to be lymphosarcoma on pre-operative biopsy. Operation was deferred. This

was three years ago, and he is still working. Lymphadenitis of the inguinal glands is very common in the labouring class, with the erroneous complaint of 'rupture'. Four cases of 'traumatic' appendicitis have been operated on with the appendix in the hernia sac.

Frequently a lipoma precedes a hernia sac and such an accumulation of fat should always be removed or the capsule well incised to eliminate a possible contributory element in possible future recurrence of the hernia. During the war a combat pilot was referred for examination complaining of sudden severe abdominal cramps followed by vomiting, weakness, sweating, and pallor. Examination revealed acute tenderness in the left inguinal canal, with a small  $\frac{3}{4}$ -in mass just distal to the internal inguinal ring. Immediate operation revealed an extraperitoneal lipoma which had been forced past the sharp edge of the deep inguinal ring, and had wedged a loop of small bowel in the inguinal canal in a small hernia sac.

The possibility of a coexisting hernia should be considered in any hernia repair. The development of a femoral hernia following an inguinal repair occasionally occurs. This may be due to the surgeon failing to detect the femoral hernia at the time of the inguinal hernia operation, or to a faulty technique in the hernia repair. The most common error is suturing the conjoined 'tendon' to the inguinal ligament, and not to Cooper's ligament.

Bursæ may occur almost anywhere in the body in the region of muscles and tendons which are subjectable to trauma. The possibility of a supernumerary bursa of the pectineus muscle is another condition to add to the long list for the differential diagnosis of hernia in the inguino-femoral region.

## CONGENITAL ATRESIA OF SMALL INTESTINE

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THE following case, being a rare type of atresia of the small intestine in the region of the middle of the midgut, may prove of interest.

### CASE REPORT

**HISTORY** — Full-term male infant, 2 days old, admitted to University College Hospital from Bromley Maternity Hospital with a history of vomiting after every attempt at feeding since birth. The vomit was of small bulk, yellowish in appearance, not projectile. The bowels had opened two or three times, a small amount of dark green material being passed.

**ON EXAMINATION** — Full-term infant weighing 9 lb 8 oz. T 97°, P 140, R 40. Spina bifida occulta. Anterior fontanelle slightly depressed, slight amount of dehydration. Abdomen very distended, tympanitic. Very tense on palpation but not tender, no masses felt, no fluid. Rather weak and unnatural cry.

**Rectal Examination** — Little finger admitted without difficulty. No abnormality encountered. Rubber tube passed 6 in without much difficulty, no passage of flatus or meconium.

**X-ray Examination of Abdomen** — The alimentary canal is distended by air, fluid levels are present in the

stomach and in the small intestine. The colon and rectum are not outlined with air.

'Meconium' film stained with methylene blue showed absence of the large vernix caseosa cells, thus pointing to complete atresia.

**TREATMENT** — Dehydration combated with subcutaneous injections of saline.

**Operation (F D)** — Day after admission (infant 3 days old). No premedication — local anaesthesia with 2 per cent novocain and adrenaline. Transverse incision through both recti and extending more laterally, immediately above the umbilicus. This gave beautiful exposure of the abdomen.

The gut was normally situated, no disorder of rotation. The stomach was distended and so was nearly the whole of the small intestine to a moderate degree. About 2 in above the ileocaecal valve there was a complete interruption in the continuity of the small intestine and its mesentery, the gap corresponding to the middle of the midgut where Meckel's diverticulum is situated. The distal end of the proximal segment came suddenly to an end with a free border to its mesentery for 8 in. it was enormously distended. The last 2 in of the small intestine proximal to the ileocaecal valve was of the size of an adult ureter and there was a free border to its mesentery.



at the upper end. The colon was of small diameter but appeared normal.

**Procedure**—The last 8 in. of the intestine above the gap were so distended that it had to be resected. The end was closed and invaginated. A side-to-side anastomosis was then performed between the small intestine

eventually replaced by the intravenous way, using the long saphenous vein above the ankle.

**PROGRESS**—The bowels worked two days after the operation and the abdomen remained soft. Hartmann's solution was then given by mouth. On the third and fourth days after the operation the infant seemed to be



FIG 462—Radiograph showing air distending the alimentary canal. Fluid levels are present in the stomach and small intestine.

immediately above the resected part and the ileum above the ileocaecal valve, using atraumatic 'arterial' silk in two layers, a through-and-through and a serous one. The abdomen was closed with catgut without drainage.

**Post-operative**—A small tube was passed through the nose into the stomach and aspirations carried out. Saline was continued by the subcutaneous route and this was



FIG 463—Mesenteric aspect of distended small intestine immediately above atresia. Note free edge of mesentery.

progressing satisfactorily, the bowels were working showing that the anastomosis was functioning. On the fifth day after the operation the respiratory rate started to rise and the general condition deteriorated. He died on the sixth day.

The immediate cause of death was bronchopneumonia, but no post-mortem examination was performed.

I wish to express my thanks to Mr E K Martin under whose care the infant was, for permission to publish these notes.

## ACTINOMYCOSIS OF THE LIVER REPORT OF AN UNUSUAL CASE

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THE following account records an unusual instance of hepatic actinomycosis complicated by bilateral pleural and possibly pulmonary involvement. So far as may be gathered from the literature on this previously almost uniformly fatal disease, a case similar in pathogenesis, course, and response to specific treatment has not previously been reported.

### CASE REPORT

A man of 39, a stockbroker before the war and during it an Army officer, had his appendix removed in 1925 at the age of 19 for acute appendicitis with peritonitis.

Drainage of the peritoneal cavity was necessary and convalescence stormy, but he eventually made a good recovery and was well until December, 1943. At this time he had a right pleurisy with effusion and with purulent sputum, which cleared up in six weeks after treatment with sulphapyridine. There was recurrence of pleurisy and fever associated with multiple joint pains and polyarticular swellings in February, 1944, at which time a diagnosis of rheumatic fever was made. This illness was terminated after one month by the coughing up, over ten days, of 5 oz. daily of greenish foul-smelling sputum, and he was well until June, 1944, when there was recurrence of the joint swellings associated with

pleurisy, this time on the left side. With this, there was cough, purulent sputum, pyrexia up to  $101^{\circ}$ , loss of weight of 2 st, and occasional pain in either shoulder on deep breathing. Apart from the shoulder pain there were no symptoms referable to abdominal visceral disease and the story appeared to point to a localization of disease primarily in the chest.

The patient was admitted to this hospital under the care of Professor G W Pickering on Sept 9, 1944.

ON EXAMINATION—A pale, thin, feverish man, pyrexia fluctuating up to  $102^{\circ}$ ; pulse 90–100, respirations 30.

Respiratory system. Left pleural effusion up to 4th rib posteriorly, right chest clear.

Cardiovascular system. No evidence of cardiac failure or enlargement or of valvular disease.

Digestive system. Some carious teeth. No other throat lesion.

Abdomen. Fully healed Battle's incision of previous appendicectomy. Liver palpably enlarged 1 in below costal margin in anterior axillary line, smooth, with some tenderness and spasm of overlying muscles. On one occasion a tender lump  $2 \times 1$  in could be detected on the anterior surface of the liver. No other abdominal lesion was demonstrated, diaphragmatic movement both sides was good, and rectal examination and examination of the urogenital system were negative.

#### Investigations

Pleural aspiration (repeated four times). Opalescent yellow fluid, culture sterile, cells lymphocytes and polymorphs, protein 3.9 mg per 100 c.c. No T.B. on slide or culture. Sputum. No T.B. Culture. Pneumococci.

Urine. No abnormality.

Blood. Culture sterile on two occasions. Total plasma-proteins 6.2 g per 100 c.c. W.B.C. 22,300 (polymorphs 78 per cent, lymphocytes 18 per cent, monocytes 4 per cent). (This polymorph leucocytosis persisted throughout.) Haemoglobin 72 per cent. R.B.C. 3,850,000.

Mantoux test. Negative to 1–1000.

Radiographs. Left pleural effusion with no evidence of underlying lung disease. Right chest clear except for slight peaking of diaphragmatic pleura. Subsequent chest radiographs showed gradual diminution of the left pleural effusion without revealing underlying lung disease.

Barium meal and excretion pyelography showed no significant abnormalities.

TREATMENT AND PROGRESS.—Two 7-day courses each of 55 g sulphadiazine were given on Sept 22 and Oct 14. Each produced the same effect—a delayed fall in the general level of the temperature and an improvement in the clinical condition. Both reverted about 10 days after stopping the drug to their previous state. Between Nov 1 and Nov 6 he was given 500,000 units of penicillin by continuous intramuscular drip—this had no effect upon the temperature, the clinical condition, or the leucocytosis.

Before, during, and after these therapeutic essays search was made in order definitely to localize the site of the hypothetical infective process. The presence of a swinging temperature with a persistent polymorph leucocytosis pointed to the presence of an infective lesion, but as the left pleural effusion receded it became increasingly clear that there was no definite evidence of lung disease. The recurrence after sulphadiazine treatment of right shoulder-tip pain with occasional hiccups, together with the persistent tender enlargement of the liver, was suggestive of infradiaphragmatic suppuration, but exhaustive clinical and radiological examination to confirm this yielded no clear evidence to support the diagnosis. It was eventually decided, in consultation with Sir Thomas Dunhill, that, in view of the continued fever and emaciation combined with the shoulder pain and liver enlargement, the evidence was enough to

justify laparotomy in search of an as yet undiagnosed subphrenic lesion.

On Jan 8, 1945, laparotomy under general anaesthesia was performed by Sir Thomas Dunhill.

The liver was exposed through a right upper paramedian incision and was seen to be free above from the diaphragm as far back as the attachment of the right coronary ligament, presenting on its upper surface about five small hard white nodules, with one fluctuant area  $2 \times 2$  in on the anterior part of the upper surface. The spleen and appendix area were surrounded with dense adhesions, but no other intra-abdominal lesion was found. One nodule from the liver was excised for section and the abdomen closed.

Aerobic culture of the nodule was sterile, while section showed the histology typical of actinomycosis, with the ray fungus clearly displayed.

Definitive treatment was started on Jan 20, 1945, by

1 Sulphamerazine 225 g in 6-hourly 1-g doses between Jan 20 and March 19.

2 Penicillin 2,400,000 units by intramuscular drip between Feb 18 and March 5.

3 Potassium iodide 15 gr daily from Jan 17 to March 3 and 45 gr daily from March 6 to March 19.

The maximum blood-level of sulphamerazine reached was 7.5 mg per 100 c.c. (free) on Feb 9.

With this treatment the patient's general condition improved slowly, he became afebrile on March 2 and a sinus forming at the upper end of the wound (from which *A. bovis* was grown on anaerobic culture) healed by March 10. On discharge, March 23, he felt quite well, had no chest or abdominal symptoms, his wound was soundly healed, and he had put on weight. Haemoglobin was 80 per cent and W.B.C. 9800 (polymorphs 66 per cent).

Progress since discharge has been satisfactory. He gained 14 lb in weight in the first month and when seen on Oct 18 weighed 11 st 6 lb and felt quite well. The chest was clear on radiography and the liver appeared normal in size, though of a firmer consistency than is usual. Haemoglobin 105 per cent, W.B.C. 8050. His latest report (March, 1946) is that he has no further symptoms, that his weight is maintained, and that he is able to lead a normal life. The abdominal wound remains soundly healed.

## SUMMARY AND CONCLUSIONS

1 A case of hepatic actinomycosis presenting with a long history of recurrent attacks of pleurisy and causing great difficulty in diagnosis is reported.

2 The unusual pathogenesis and course is noted. Liver involvement in this case may have been secondary to the appendicitis of twenty years ago or to lung disease. Bilateral pleurisy with effusion is noted as a complication not previously reported, as also is the small size of the lesion as seen at operation (possibly due to the previous treatment with sulphonamides).

3 The temporary beneficial effect of two inadequate courses of sulphadiazine and the lack of response to one insufficient course of penicillin is noted.

4 Recovery with maintenance of good health for over a year following treatment by massive doses of sulphamerazine and penicillin is reported.

My thanks are due to Professor Pickering and to Sir Thomas Dunhill for their permission to record this case, and for their continued interest in and help with this report. For histological, bacteriological, and other investigations I am much indebted to Dr D M Pryce and Dr C N Iland.

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## CALCIFICATIONS IN LIVING TISSUES

By JOHN T MORRISON, LIVERPOOL

FOUR examples are recorded of calcification of tissues, of clinical interest in themselves and as illustrations of this curious pathological process

The first is taken from an old woman in whom hard nodules were discovered in both breasts in the course of a routine examination The stony

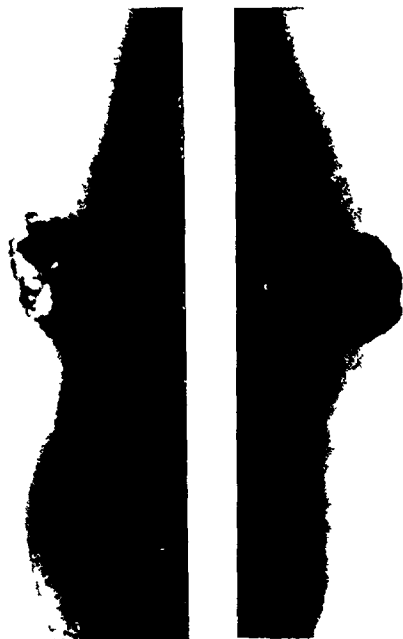


FIG 464—Case 1 Lateral view of calcified fibro-adenomata in both breasts

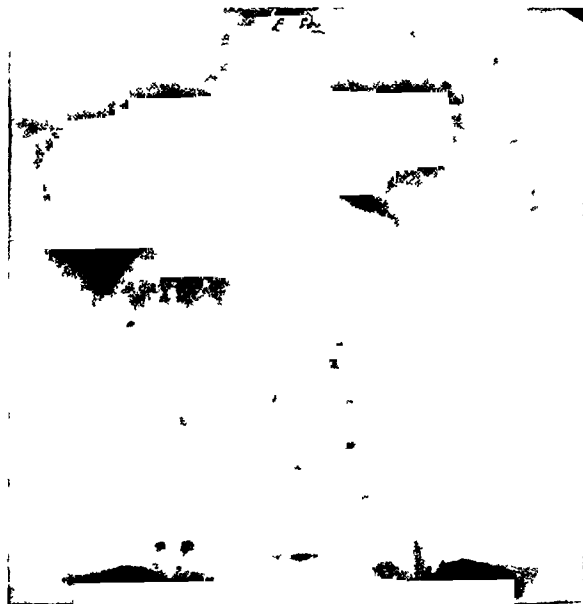
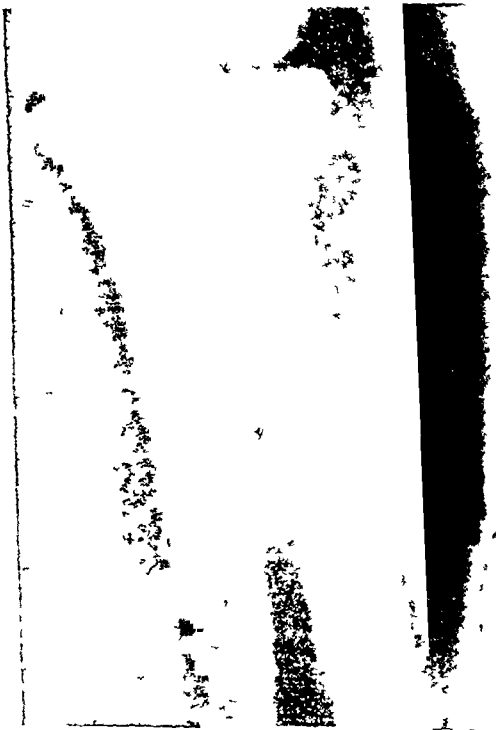


FIG 465—Case 2—Numerous calcified masses in the liver and spleen The outline of the lower pole of the latter is clearly seen, and the crescentic distribution of the masses in the spleen is characteristic

hardness at once aroused suspicion as to the diagnosis and this was confirmed by lateral X-ray views of the breasts (*Fig 464*)



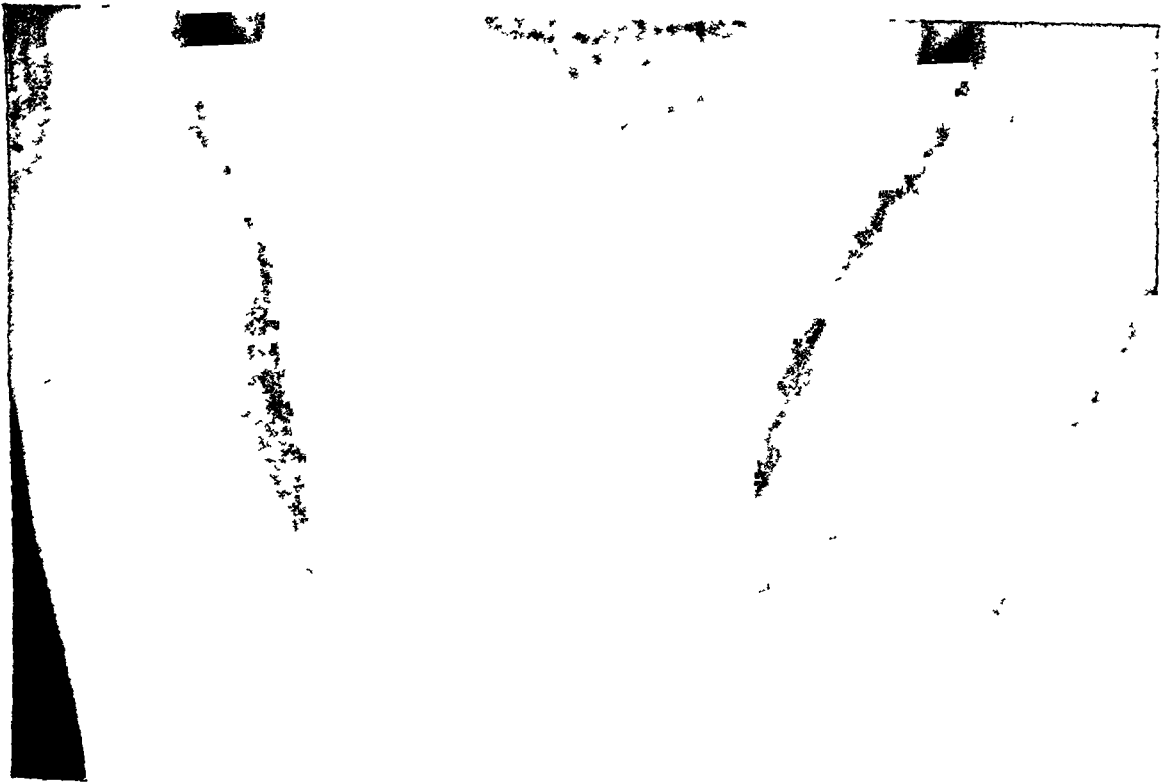
*FIG 466*—*Case 3*. A tangential view of the forearm showing the calcification in the superficial scars

The second is the radiograph of an abdomen taken in the course of investigation of a woman of 48 suffering from urinary tuberculosis (*Fig 465*). Right nephrectomy had been performed some years earlier. Symptoms had now recurred as the result of infection of the left kidney. There was nothing in the clinical history to suggest at what date the extensive tuberculous disease in the liver and spleen had occurred.



*FIG 468*—*Case 4*. Lateral view, showing the very superficial position of the calcified area

The third is a photograph of a young man who, in early childhood, had suffered from diphtheria. After injections in the forearms suppuration had apparently followed—as witness the incisions—and now the scars are broad, smooth, pinkish, depressed, and bony-hard to the touch (*Figs 466, 467*). The condition gives rise to no disability, and so far no trophic disturbances over the calcareous deposits.



*FIG 467*—Forearms of *Case 3*, showing scars in which calcification had taken place

have been noted. The Wassermann reaction was strongly positive, but this is presumably merely a coincidence.

The fourth is a lateral radiograph of the foot of a child of 6, a patient of Dr W A Mackay, of Southport, to whom I am indebted for the photograph. The calcified nodule was covered by thin adherent skin (Fig 468). The mass was excised for histological examination. It proved to be a benign calcifying epithelioma, with advanced degeneration and calcification so that only the ghosts of the epithelial

masses remained. Another example of this peculiar kind of tumour was recently observed in the scalp of a child only eight months old, the general histological appearances were similar, but the epithelial masses were much less degenerate.

These are all, of course, examples of calcification in the classical conditions of diminished blood-supply. The subject is comprehensively discussed in the illuminating article by Watson-Jones and Roberts in *The British Journal of Surgery*, 1934, 221, No 83.

## AN UNUSUAL CASE OF INTUSSUSCEPTION

By CLIFFORD JONES, MBE

FIRST ASSISTANT, SHEFFIELD ROYAL INFIRMARY

OWING to the unusual causation of this case of intussusception, it has been considered worthy of being placed on record.

### CASE REPORT

On Feb 8 1946, a male aged 54 was admitted to the wards of Professor R St Leger Brockman at the Royal Infirmary, Sheffield, complaining of acute colicky pain

ON EXAMINATION—The patient was a thin spare individual, the abdomen was slightly distended, particularly in the lower half. There was no visible peristalsis and nothing abnormal was heard on auscultation.

On palpation a hard mass was felt in the right iliac fossa, which was slightly tender. There was no rigidity.

On rectal examination nothing abnormal was found. A provisional diagnosis of carcinoma of the cæcum was made.

During the next few days the bowels opened naturally and there was no pain. On Feb 15 the patient had another attack of intense colicky pain. The abdomen was now very tender and difficult to examine, but was not grossly distended. There had been no vomiting. A tentative diagnosis of acute on chronic obstruction was made and a laparotomy was performed.

OPERATION (C J)—General anaesthetic open ether. Right lower paramedian incision. On incising the peritoneum there was a copious flow of brownish odourless fluid in which there were many flakes of fibrin. On exploring the right iliac fossa a mobile mass was found which extended along the ascending colon and a proximal part of the transverse colon. The cæcum formed a cuff around the entering small bowel which could be readily entered with exploring fingers and it was then realized that it was an intussusception of the ileocolic type. Reduction was impossible and as the patient's condition was good, a right hemicolectomy was performed with an end-to-side anastomosis of ileum into transverse colon.

Convalescence was uneventful and the patient was discharged home on March 4.

THE SPECIMEN—Consists of the lower ileum, cæcum, and colon. The ileum is intussuscepted into the colon for 9.5 cm. At the apex of the intussusception there is a hard hæmorrhagic mass 10 cm in length. This mass is arising from the wall of the ileum. The ileocaecal valve is grossly dilated and the mass had obviously passed through the valve, drawing the ileum after it. The entering and returning layers of the intussusception are covered with a fibrinous exudate and are adherent to one another. A large section of the mass shows a necrotic and hæmorrhagic surface, but with the structure of a fibroma. Scattered throughout the section are groups of plain muscle-fibres. It is, therefore, classed as a fibro-leiomyoma of ileum.

My thanks are due to Professor R St Leger Brockman for permission to publish the case and to Dr L C D Hermitte, Pathologist to the Royal Infirmary, for help in examining the specimen and for the photography.



FIG 469—Photograph of the portion of intestines removed at operation, showing the ileocolic intussusception.

in the abdomen which was chiefly sub-umbilical in situation. There was a history of occasional pain in the right iliac fossa for five months previously, and this had been accompanied by some loss in weight and a feeling of general ill health. On the night of Feb 7 he was seized with acute abdominal pain, colicky in nature, and had vomited twice. The bowels were opened on Feb 6 but not since. There were no other relevant points in the history.

## FIBROMA PENDULUM

BY N DUGGAN, WORCESTER

IN a recent number of this JOURNAL (1944) I reported the case of a very large lipoma growing from the right side of the neck. The accompanying illustrations depict an even more fantastic incubus,

complicating a case of neurofibromatosis and arising from the same area of the body. Sequeira (1927) gives the name 'fibroma pendulum' to these large pendulous tumours.



FIGS 470, 471 —Photographs showing the extent of the tumour



FIG 472 —Photograph showing the neurofibromatosis

## CASE REPORT

The patient, a healthy and intelligent woman of 72, stated that the condition was congenital. No other members of her family have been affected.

She recalls that in childhood the tumour was 6-8 in long. It reached to her waist for most of her adult life, and has grown rather rapidly during the past two years. No great pain was felt, and the life-long burden was accepted as a matter of course. She has never consulted a doctor for any reason, until two years ago, when she fractured her clavicle, and the attending doctor suggested that operation might be worth consideration.

She was admitted to hospital in March, 1946, and several days were occupied in thorough pre-operative cleansing of the skin by cetavlon and sulphonamide cream.

At operation, which was performed entirely by diathermy, the pedicle, consisting mostly of hypertrophied platysma and dilated veins, was easily divided and the skin sutured to make a linear scar 9 in long.

The wound, which was dusted before closure with penicillin and sulphonamide powder, healed well by first intention, except for a small central area where a rubber drain had been inserted. The tumour on removal weighed  $7\frac{1}{2}$  lb.

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## CASE OF SARCOMA OF STOMACH SIMULATING SPLENIC TUMOUR

By B WOLMAN

RESIDENT MEDICAL OFFICER, WITHINGTON HOSPITAL, MANCHESTER

GASTRIC sarcoma is a sufficiently rare lesion to warrant the recording of any new case. The following case, seen at Ancoats Hospital, provided an interesting problem in diagnosis.

### CASE REPORT

The patient, a married woman aged 34 years, was admitted to hospital on Jan 20, 1943, complaining of a large, painful swelling in the left side of the abdomen of nine to ten weeks' duration. The pain, situated over the swelling, was continuously dull and aching, but gave rise to acute exacerbations of grating nature. Appetite

below the left costal margin towards the midline and reaching down as far as the level of the iliac crest. It was impossible to get between the mass and the costal margin, but it was obvious that the tumour was not coming out of the pelvis. The tumour was superficial and tender. It had a smooth surface and irregular anterior edge, although there was no definite notch. The liver edge, distinct from that of the tumour, was palpable and found to be regular and smooth. There was no oedema and no ascites.

**DIAGNOSIS**—Clinically, the mass resembled an enlarged spleen. True, it was tender, and had an irregular anterior border and no definite notch, but a possible diagnosis was perisplenitis and infarcted spleen due to recurrent emboli resulting from auricular fibrillation.

The length of the history and the fact that the condition was not settling were against the acceptance of this diagnosis.

The coexistence of anaemia, enlarged liver, and enlarged spleen suggested pernicious anaemia as a diagnosis. This was confirmed by a peripheral blood-count of the macrocytic hyperchromic type as follows—

Hæmoglobin 50 per cent

Red blood-corpuscles 1,820,000 per c mm

Colour index 1.38

White blood-corpuscles 5000 per c mm—in normal proportions

There was 1 per cent of nucleated red blood-cells, and marked anisocytosis and poikilocytosis.

Examination of the sternal marrow was as follows—

	per cent
Hæmatoblasts	2.5
Megaloblasts	7.75
Normoblasts	8.5
R B C nucleated	6.0
Lymphocytes	8.5
Monocytes	0.25
Myeloblasts	3.5
Myelocytes	10.25
Metamyelocytes	18.5

Although a fractional test-meal revealed complete achlorhydria, the extreme tenderness of the 'splenic' swelling contra-indicated the diagnosis of pernicious anaemia.

The possibility of a gastric or colonic neoplasm was considered, but unfortunately the patient was far too ill to stand a barium meal and gastric X-ray examination. A renal lesion was eliminated by a normal intravenous pyelogram.

It was decided to give a short test course of daily liver injections (Lederle Liver Preparation 3 c.c.), together with iron and hydrochloric acid, but after two weeks there had been no reticulocyte response and, in fact, the hæmoglobin had fallen to 44 per cent.

**LAPAROTOMY**—In view of the vagueness of the diagnosis and the demand by the patient that something drastic should be done to relieve her suffering, an exploratory laparotomy was performed after an emergency blood transfusion had been given.

The mass was not splenic but gastric in origin and consisted of a neoplasm of the lower half of the body of the stomach, around which was wrapped the greater omentum containing numerous secondary deposits. There were metastases throughout the peritoneum, but the liver, although enlarged, was free of secondary

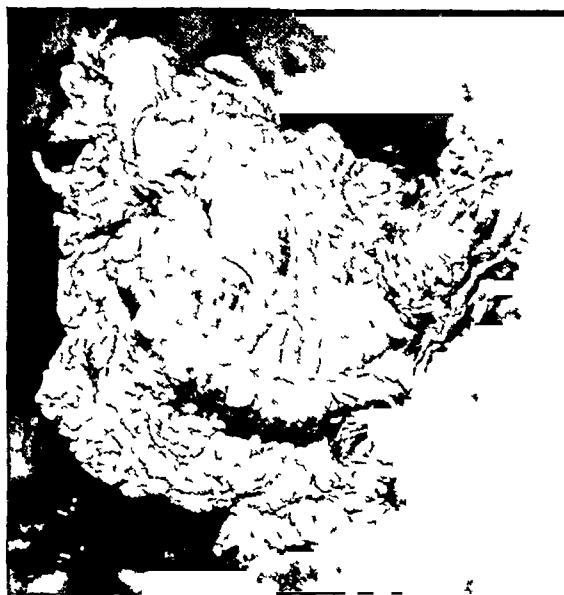


FIG 473—Showing external appearance of stomach, colon and mesentery

was good. There was no nausea or vomiting. Her bowels, always constipated, had not been increasingly so during the present illness. There were no urinary complaints, but her menses had stopped seven months previously. She was losing weight, but had no idea of the exact amount.

Her previous history was unimportant apart from the fact that she had "rheumatism" when she was a child.

**ON EXAMINATION**—The patient was frail, thin, and obviously very poorly. The mucosæ were very pale, the tongue was clean, and the throat healthy. There were no glands palpable in the neck, groins, or axillæ.

The heart was enlarged to the left, with a definite auricular fibrillation—about 100 per minute. Blood-pressure was 120/70 and there were no abnormal clinical signs in the lungs.

The abdomen was distended and showed the patchy pigmentation of erythema *ab igne* over the whole of the left side. There was a large tumour extending from

growth The abdomen was closed The patient collapsed suddenly on the third day after operation and died

At Autopsy —The above findings were corroborated The liver was enlarged and showed passive venous congestion The spleen was normal in size, but there

an early case the treatment is resection of the growth, although the lymphosarcoma variety are reported to be sensitive to deep X rays

The case reported here is interesting as a diagnostic problem (1) on account of the character

of the tumour itself, and (2) because of the other clinical findings The development of a macrocytic hyperchromic anæmia of a pernicious anæmia type is interesting as it is not usually a feature of gastric sarcoma, although, of course, it is very common in carcinoma Achlorhydria also is a variable sign

Extreme tenderness of the tumour, coupled with the absence of nausea and vomiting, served as efficient pointers—away from the gastro-intestinal tract

### SUMMARY

1 A new case of gastric sarcoma is reported, together with autopsy and histological findings

2 The interesting features in the differential diagnosis are discussed

My thanks are due to Dr G J Langley for permission to report the case, and to Dr F Duran-Jorda for the microphotographs

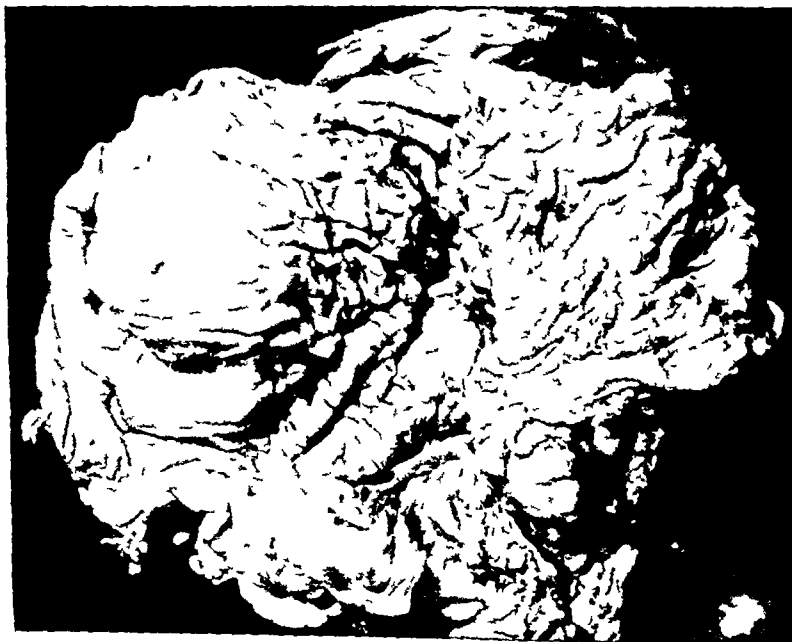


FIG 474—Stomach opened to show normal mucous membrane

was a tumour mass extending into the hilum The tumour itself involved the wall of the lower half of the body of the stomach, and the omentum and mesentery, studded with many hard deposits, were wrapped around it so as to simulate a tumour much harder and larger than actually existed There were dense adhesions between the mass, the anterior abdominal wall, and all surrounding viscera The cavity of the stomach and the mucosa appeared to be normal (Fig 474) Microscopical examination of the tumour revealed a spindle-celled sarcoma (Fig 475) The remaining viscera were not examined, as permission was only given for abdominal autopsy

### DISCUSSION

Early case records of sarcoma of the stomach were reported by Warner (1917) and Barrington-Ward (1916), and Haggard reviewed 244 cases in the literature in 1920 It occurs infrequently, Ewing (1940) estimating that sarcoma appeared as only 1 per cent of gastric tumours The Mayo Clinic reported a yearly incidence of 1 to 6 cases (Hurt and Broders, 1932)

The average age of incidence of the reported cases was 40 years, while that of carcinoma was 55 years The sex incidence is about equal The growth is commonest on the lesser curvature and is usually diagnosed as carcinoma Sarcomata may be diffusely infiltrating or nodular in type The spindle-celled variety is commonest It is rarely possible to make a correct pre-operative diagnosis, although the X-ray picture may be suggestive In

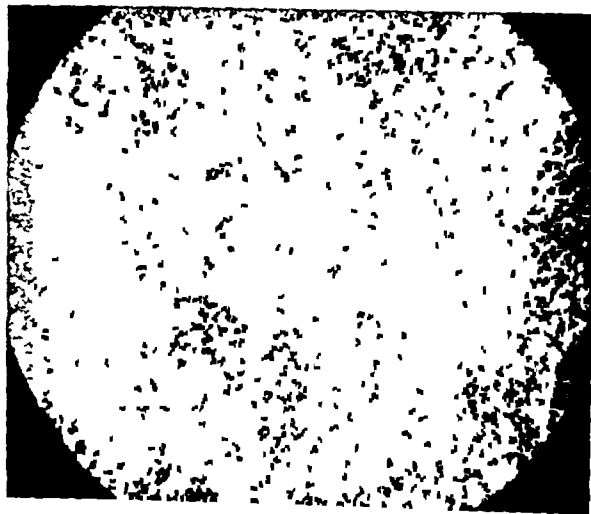


FIG 475—Microscopical appearance, showing spindle-celled sarcoma

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## A CASE OF CARCINOMA OF THE ILEOCÆCAL VALVE, WITH FORMATION OF A SPONTANEOUS ILEOCÆCAL FISTULA

By F R R MARTIN

RESIDENT SURGICAL OFFICER, LEEDS GENERAL INFIRMARY

SPONTANEOUS formation of fistulæ is not uncommon in carcinoma of the large intestine. Lockhart-Mummery (1934) describes two ways in which they may arise. (1) The growth becomes adherent to an adjacent viscus and, as ulceration occurs, the central

intestinal obstruction. At laparotomy a small growth was palpated in the ileocæcal valve, the lumen of the gut being obstructed at this level. A considerable length of terminal ileum was dilated and hypertrophied. An anastomosis was made between the ileum and transverse colon. Unfortunately a low-grade peritonitis occurred and the patient died some five weeks later.

At autopsy the condition depicted in the accompanying photograph (Fig 476) was found. The terminal ileum (right) and the cæcum and ascending colon (left) have been laid open, disclosing a nodular growth which completely encircles the ileocæcal valve, causing very great narrowing of the lumen. Further examination revealed the presence of a narrow fistulous track through the base of the ileocæcal valve, external to the growth, and apparently not directly related to it. The fistula was about 1.5 cm in length and some 5 or 6 mm in diameter. It was situated posteriorly to the natural lumen. A tapered glass rod has been passed through the fistula from the cæcal aspect.

Histologically, the tumour is a fairly well-differentiated adenocarcinoma, probably of comparatively slow growth. It has extensively infiltrated the muscular coat. Much inflammatory change is present in places in the stroma.

**Comment**—The fistula had probably arisen by a simple ulcerative process resulting from the chronic obstruction.

Another instructive feature of this case is the fact that, in spite of the presence of the fistula, acute intestinal obstruction had developed. This finding is in agreement with the opinion of Lockhart-Mummery (1934), who states that the occurrence of fistulæ will not, as a rule, prevent the onset of obstructive symptoms.

My thanks are due to Professor Stewart for his advice in preparing this short note and to Mr Digby Chamberlain for his permission to publish this case.

### REFERENCE

LOCKHART-MUMMERY, G. P. (1934), *Diseases of the Rectum and Colon*, 538. London: Bailiere, Tindall & Cox.

### CASE REPORT

T. T., aged 58, was admitted to the General Infirmary, Leeds, on Dec. 18, 1945, with symptoms of subacute



FIG 476—Photograph of the terminal ileum and cæcum, showing the carcinoma of the ileocæcal valve and the fistula.

portion gives way, leaving a communication between the two. (2) The growth in the colon becomes ulcerated, and the ulcer perforates the bowel wall, forming a pericolic abscess, which, in its turn, ruptures into an adjacent viscus.

The case described below is of interest because the fistula found in the immediate neighbourhood of a carcinoma of the ileocæcal valve cannot be said to have been caused by either of the processes described above. Furthermore, on looking through the literature, I can find no mention of a similar case.

## TUBERCULOSIS OF MECKEL'S DIVERTICULUM

By IAN B. MACDONALD

DEPARTMENT OF PATHOLOGY, UNIVERSITY OF TORONTO

TUBERCULOSIS of Meckel's diverticulum is exceedingly rare, only 9 authentic cases having been reported in the literature. The earliest of these was recorded by Concato in 1871, and the most recent in 1932 by Paul Michael. Of these cases none was diagnosed clinically.

In 1809 Meckel described this congenital diverticulum as a remnant of the omphalomesenteric duct. Since that time an ever increasing list of pathological complications have been recognized, varying from heterotopic gastric or pancreatic tissue to ulcers, neoplasms, and mechanical obstructions. In recent

years surgeons have become increasingly aware of pathological changes in this structure as a source of abdominal crises

The incidence of Meckel's diverticulum is 1 to 2 per cent, of which about 33 per cent display various abnormalities (Balfour, 1911). It is obvious, therefore, that in only a very small percentage of persons will this vestigial pouch be associated with pulmonary tuberculosis, about half of these will have intestinal tuberculosis, and tuberculous infection of the diverticulum will be most uncommon. Various complications may be superimposed upon this lesion, such as intestinal obstruction or perforation of the ulcer with a subsequent tuberculous peritonitis, and clinical evidence of these conditions may be produced

### PATHOGENESIS

Ulcerative tuberculous enteritis is generally regarded as a primary lesion in children, whereas in adults it is secondary to pulmonary tuberculosis. Primary tuberculous infection in a Meckel's diverticulum has never been reported, and is apparently unknown. Tuberculous infection occurs rather as a lesion secondary to tuberculosis elsewhere in the body. The tubercle bacilli may either be carried to the intestines by the blood-stream from a focus in the lungs or swallowed in the sputum, and penetrate the intestinal mucosa to form a secondary lesion in the bowel wall. The latter process is the probable explanation of tuberculous diverticulitis, and is also applicable to infection of the appendix. Coley (1925) reports a case of simultaneous tuberculous involvement of the appendix and the diverticulum of Meckel.

### CASE REPORT

**CLINICAL HISTORY**—W. T., a white Canadian aged 65, was admitted to the Toronto General Hospital on Sept 4, 1945. Nine months previously he had developed a cough productive of thick yellowish sputum. At the same time he began to manifest symptoms of cardiac failure, which increased in severity until the time of death. At no time was there any abdominal distress.

**AT AUTOPSY**—The heart was greatly enlarged, the foramen ovale was widely patent, and there was an aneurysm of the pulmonary artery. The upper lobes of both lungs, including the apices, and the right lower lobe contained numerous small caseous areas. No gross cavities were present. The bronchial and peribronchial lymph-nodes were normal.

A Meckel's diverticulum was present, measuring 3 cm in length and arising from the ileum 55 cm proximal to the ileocaecal junction. Its tip was attached to the parietal peritoneum by a few friable adhesions. The serosal surface of this diverticulum was dark red, with many white, pin-point nodules scattered diffusely over it (Fig 477). Its lumen was patent throughout and continuous with that of the ileum. The mucosa was also dark red and an ulcer about the size of a 25-cent piece was present, the edges of which were rolled and had a velvety appearance. The base of the crater was firm, smooth, and of a similar colour. No other lesions of the gastro-intestinal tract were present.

Microscopically the pulmonary lesions showed a picture of active tuberculosis, consisting of patches of caseation surrounded by epithelioid cells, giant cells, and lymphocytes. The ulcer in the diverticulum was also tuberculous. The mucosa was necrotic and infiltrated with inflammatory cells. A few scattered tubercles were present in the subserosa.



FIG 477—Showing the dark red serosal surface of the diverticulum, with many white pin-point nodules scattered diffusely over it.

This patient died as the result of cardiac insufficiency due to pulmonary tuberculosis. This latter was regarded as the source of infection of the diverticulum.

### SUMMARY

1 A case of tuberculous ulcer of Meckel's diverticulum is reported, secondary to pulmonary tuberculosis.

2 The ulcer was unaccompanied by clinical symptoms and there were no other tuberculous lesions of the gastro-intestinal tract.

3 This is the tenth case recorded since 1871.

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## MULTIPLE CAPILLARY HÆMANGIOMA OF THE SKULL BONES

By A S HANDOUSA BEY

PROFESSOR OF OTORHINOLARYNGOLOGY, FOAD I UNIVERSITY, CAIRO, EGYPT

HÆMANGIOMA of bone is a very rare finding, the majority of the recorded cases are of the cavernous type Mary S Sherman (1944) reported a case

In view of this extreme rarity of capillary hæmangioma of bone I feel the following case is worth recording It was discovered in the skull bones in two situations and was found to be the sole cause of the proptosis for which the patient sought medical advice

## CASE REPORT

Moh A T, male, aged 36 years (*Fig 478*), complained of right-sided, gradually increasing proptosis of about one year's duration, associated with excessive lacrimation There was no pain and no history of trauma or syphilis The patient stated that in childhood he had a severe eye illness (? purulent ophthalmia) followed by loss of vision of his left eye

ON EXAMINATION—Clinically the right eye was markedly proptosed, mainly forwards and downwards, with increased vascularity of the upper lid and congestion of the conjunctiva, with slight limitation of the globe movements mainly upwards and outwards There was a minute nebula on the right cornea (at 5 o'clock), the pupil reacted normally, intra-ocular tension was normal

The superior orbital margin was markedly thickened, especially at its outer part, but not tender An intra-orbital firm mass was felt in the outer orbital corner (? dislocated right lacrimal gland), which was slightly tender on pressure

There was no pulsation felt over the frontal bone or the orbital contents, the proptosed structures were not reducible

Right optic disk was swollen, with a hazy margin

Right vision 6/36 Right field of vision showed concentric contraction in all directions

Left eye showed diffuse keratitis, otherwise there was nothing special

The skull showed no swellings or tender points

There was right-sided maxillary and ethmoid sinusitis with nasopharyngitis

Radiological Examination (*Figs 479, 480*) showed two wheel-like shadows lying in and distending the diploic part of the bone between the two



FIG 478—Photograph of patient, showing the proptosis

of capillary hæmangioma which was situated in the distal metaphysis of the left femur, and could only find 4 other cases of the same type recorded in the literature



FIGS 479, 480—Radiographs showing shadows lying in and distending the diploic part of the bone between the two tables, with bony trabeculae radiating towards the periphery

diploic part of the bone between the two tables, and was characterized by having bony trabeculae radiating from a common centre towards the periphery. One of these shadows lay in the right side of the frontal bone and the other in the right parietal bone.

The X-ray investigation was first made by Dr Sinna, to whom I am indebted for the preliminary diagnosis of haemangioma of bone. Further X-ray investigations were kindly carried out by Dr Mary Bey and Dr Nissim Bey Abou-Saif (Figs 479, 480). The rest of the skeleton was radiologically normal.

**Blood-picture —**

Hb 72 per cent Erythrocytes 4,200,000 Leucocytes 7200

Polymorphonuclears	56 per cent
Lymphocytes	30
Eosinophils	10
Hyaline	4

WR Negative before and after provocation

CSF Free of any abnormality

**AT OPERATION**—Exploration of the right frontal bone shadow was carried out, and it was noticed that the tissues over it were very vascular, the periosteum and outer table of the frontal bone were found intact, when the outer table was cut through, the diploic spaces were found markedly dilated and full of very vascular tissue, which bled freely. A small piece was removed and submitted to microscopical examination.

Professor Sorour Bey reported. The section sent shows normal bony trabeculae with capillary angiomatosis



FIG 481—Microphotograph showing normal bony trabeculae with capillary angiomatosis in the intervening fibrous tissue

in the intervening fibrous tissue. Fig 481 is a microphotograph from this case demonstrating these findings.

On account of the multiplicity of the tumour and the extensive lesion produced, excision has been deferred until a course of deep X-ray therapy has been tried.

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SHERMAN, MARY S (1944), *Arch Path*, 38, 158

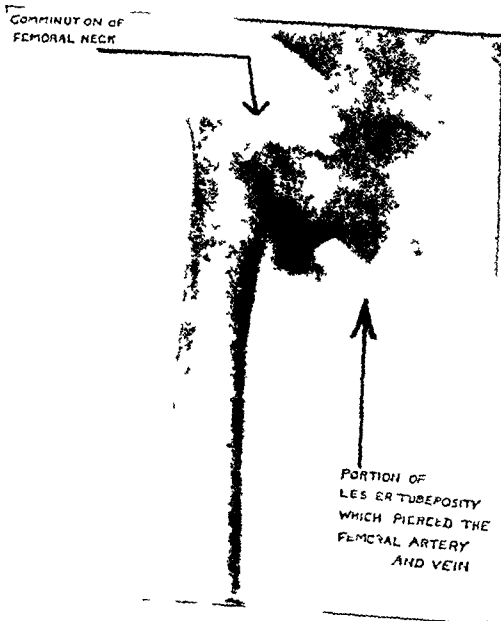
## ARTERIOVENOUS ANEURYSM AS A COMPLICATION OF INTER-TROCHANTERIC FRACTURE OF THE FEMUR

BY T A QUILLIAM

RESIDENT ASSISTANT SURGEON, ST CHARLES' HOSPITAL, LONDON

### CASE REPORT

Mrs M H, aged 86 years, was admitted to this hospital on Dec 19, 1945, having fallen and injured her right hip earlier on the same day.



An intertrochanteric fracture of the right femur was diagnosed and this was confirmed upon X-ray examination, which revealed that considerable comminution of the fragments was present (Fig 482). A Steinmann pin was inserted through the tibial crest and an extension of 15 lb was applied with the aid of a Thomas splint and a Pearson bed attachment.

FIG 482—Radiograph taken on admission showing comminuted intertrochanteric fracture

The patient was very senile and was incontinent, but her condition progressed in a fairly satisfactory manner for nearly a month, after which her back and perineum became ulcerated and failed to respond to treatment. On Jan 21, 1946, the pin and splint were removed and on Jan 22, a painless lump made its appearance in the right groin. Arterial pulsation (which could not be obliterated by digital pressure) and a systolic thrill were palpable. Auscultation over the lump in the groin

revealed a continuous 'machinery' murmur. The blood-pressure reading was 120/50 but, unfortunately, no note had been recorded of this previously. The patient died on Jan 24.

" a comminuted fracture was found through the trochanters of the right femur and the lesser trochanter had become almost separated from the rest of the femur, rotated, and driven forward between the femoral artery

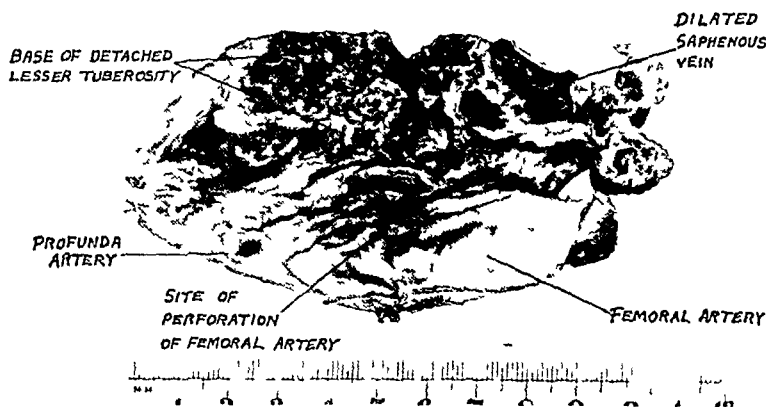


FIG 483—Photograph of specimen removed post mortem

AT AUTOPSY—An extract of the post-mortem report, by kind permission of Dr R D Teare, is appended, together with a photograph of the specimen removed (Fig 483).

and vein, penetrating both vessels and forming an arterio-venous aneurysm. The saphenous vein was grossly dilated and packed with blood. There was some extravasation of blood into the tissues of the thigh."

## REVIEWS AND NOTICES OF BOOKS

**Röntgen Diagnosis of Diseases of the Gastro-intestinal Tract** By JOHN T FARRELL, jun, M D, Clinical Professor of Radiology, Graduate School of Medicine, University of Pennsylvania. 9 x 6 in. Pp 271 + x, with 190 illustrations. 1946. Springfield, Ill. C C Thomas (London: Baillière, Tindall & Cox) 30s.

THIS book contains a large collection of pictures to illustrate all the well-known abnormalities and diseases of the alimentary tract, but it is much more than an atlas of radiography. The text is based upon lecture notes given to post-graduate students in the University of Pennsylvania, and contains valuable and detailed advice about the preparation of patients, the position of the body during examination, and a little about radiological technique. It lays stress upon the methodical observation of certain features such as the contour, mobility, and position of the various organs—a necessary preliminary to the writing of a complete report.

The arrangement of the material follows the pattern of the topographical and aetiological classifications used in the *Standard Classified Nomenclature of Diseases*, and while this has ensured a full consideration of the alimentary canal and made certain that nothing could be omitted, it has resulted in a good deal of overlapping, so that conditions such as cardiospasm and diaphragmatic hernia appear several times over. This is irritating and confusing to the reader, and may even be unreasonable, as when we find duodenal ulcer, because it is classified as a disease due to unknown or uncertain cause, thirty pages after the beginning of the section on the duodenum, with diseases of the small intestine such as ileitis, tuberculosis, and intestinal obstruction interposed.

A book of this type should aim at giving more than a mere description of radiographic outline. For example, it is not enough to state that in the Plummer-Vinson syndrome the thin barium stream may be divided as

though cut by a web, without offering any explanation of this phenomenon or any reference as to why the obstruction occurs and how it responds to treatment by iron. Incidentally, it is rather confusing to introduce disorders of the pharynx under the heading 'oesophagus'. No doubt these matters of detail may be rectified in future editions, so that the good promise of the publication may be more completely fulfilled.

**Buchanan's Manual of Anatomy** Edited by F WOOD JONES, D Sc, F R S, F R C S, Sir William Collins Professor of Human and Comparative Anatomy at the Royal College of Surgeons of England, assisted by E L PATTERSON, S MOTTERSHEAD, T E BARLOW, F R WILDE, and JESSIE DODSON. Seventh edition. 8½ x 5½ in. Pp 1616 + viii, with 847 illustrations and 48 plates. 1946. London: Baillière, Tindall & Cox. 45s net.

It is truly refreshing to see the seventh edition of this famous anatomy text-book, which has been largely rewritten by Wood Jones, assisted by the staff of the Department of Anatomy, University of Manchester. It is, in fact, a new book with new illustrations, new figures, and a new presentation. It was a kindly thought to include a picture of Professor A M Buchanan as a frontispiece.

*Buchanan's Manual of Anatomy* has for forty years been distinguished as being the standard text-book on the gross topographical anatomy of the human body. It was designed to be a guide to the structure of the human body as it is revealed in the process of dissection, and as such has served many generations of students.

The correlation of topographical anatomy as displayed by dissection with the appearance revealed by X rays, is one of the most important developments of modern anatomical teaching, and it is pleasing to see nearly fifty excellent X-ray plates in this new edition.

The glossary has always been a feature of this book and is such a boon to the student, as he is often at a loss to know the meaning of certain anatomical terms. In this edition there are biographical notes of those anatomists whose names occur eponymously in the text, an excellent idea of the new editor.

Students and practitioners the world over are familiar with Wood Jones's other works, especially those on the hand and the foot. In this new edition over 200 drawings by Wood Jones are included in the volume. It is refreshing to see these clear illustrations, which enormously enhance the written work. There are no coloured drawings in the book and we congratulate the editor and publishers in taking this step, for the multicoloured illustrations of anatomy text-books leave much to be desired, for no one ever sees the tissues in these colours, in either the quick or the dead.

We have nothing but praise for this book, and we predict that this seventh edition will maintain the book's firmly established place among English books of anatomy, and we wish it every success.

**Gray's Anatomy, Descriptive and Applied** Edited by T B JOHNSTON, C B E, M D, Professor of Anatomy in Guy's Hospital Medical School, University of London, and J WHILLIS, M D, M S, Reader in Anatomy, Guy's Hospital Medical School, University of London. Twenty-ninth edition.  $9\frac{1}{2} \times 6\frac{1}{2}$  in. Pp 1597 + xix, with 1359 illustrations, of which 642 are coloured and 47 X-ray plates. 1946. London: Longmans, Green & Co. 70s net.

THE new Gray will make a strong appeal to all surgeons both at home and abroad because the practical or applied aspect of anatomy is set in its proper place.

The new volume contains some 200 new illustrations, mostly from the pen and brush of that well-known artist, A K Maxwell. It is a pity, however, that the poor quality of the paper has prevented the blocks from being good and clear reproductions. Some of the illustrations have merged through the paper and have appeared on the next page.

There is, perhaps, too much small type which is difficult to read. If it is considered by the authors as of little import it would be better omitted.

However, these criticisms are small when the book is considered as a whole, for many generations of surgeons have used it as a reference book and many more will use it in the days to come. To-day it is the anatomical reference book not only of general surgeons but of all surgeons who specialize in the different branches of surgery.

**The Treatment of Acute Intestinal Obstruction** By JUDSON T CHESTERMAN, M R C P (Lond), F R C S (Eng), F A C S, Surgeon, City General Hospital, Sheffield, Hon Lecturer, Surgical Pathology, Sheffield University.  $8\frac{1}{2} \times 5\frac{3}{8}$  in. Pp 116 + viii, with 13 illustrations. 1945. London: J & A Churchill Ltd. 10s 6d net.

THIS small book gives in the compass of a hundred pages a clear account of intestinal obstruction from the viewpoint of interference with intestinal function. The author assumes familiarity with the commoner pathological conditions which cause intestinal obstruction and, although he devotes one-half of his space to the consideration of special obstructions and their treatment, in the main his discussion begins where the text-book stops. His account of the subject is founded on personal clinical experience and experimental observation and has the authority which such a basis gives.

It begins with a consideration of the pathology induced by acute intestinal obstruction and of the additional effects which may follow its release. The results of distension

and strangulation were watched through a transparent window in the abdominal wall of cats and these are compared with clinical observations in man.

In the section dealing with diagnosis there is a short, clear description of the value of X-ray films illustrated by plates.

The value of suction in its relation to operation is fully discussed and the operations applicable to different types of obstruction are briefly described.

A short list of references to the more important recent literature is given at the end of each chapter.

**Synopsis of Genitourinary Diseases** By AUSTIN I DODSON, M D, F A C S, Richmond, Va. Fourth edition.  $7\frac{3}{8} \times 4\frac{5}{8}$  in. Pp 313, with 112 illustrations. 1945. London: Henry Kimpton. 18s net.

WITHIN the limits imposed by its size, this book contains a vast amount of information, although it is of necessity somewhat condensed, it is still readable. Amongst the chapters to be singled out for particular praise are those on the aetiology and prevention of urinary calculi and on the non-tuberculous infections of the urinary tract, this latter chapter contains useful tables for an acid-ash diet.

We cannot agree with a method of urethral instrumentation which involves a routine change of hands during the manoeuvre, but this is probably a relic of the old-fashioned habit of working from the left of the patient.

We can recommend this small book with every confidence for the student who wishes to know the essentials of the subject, it makes a good companion for the author's larger text-book of urological surgery.

**Chemotherapy Yesterday, Today, and Tomorrow** The Linacre Lecture 1946. By Sir ALEXANDER FLEMING.  $7\frac{3}{8} \times 5$  in. Pp 39, with 5 illustrations and 2 plates. 1946. London: Cambridge University Press. 2s net.

THIS pamphlet contains an account of Sir Alexander Fleming's experiments to show that the older antiseptics were more toxic to leucocytes than to bacteria, a review of the sulphonamides which, though much more toxic to bacteria than to leucocytes, may have poisonous effects on the whole organism, and the grounds for regarding the newer antibiotics as superior to any other chemotherapeutic agents.

In looking forward to further developments, for "it is the glory of a good bit of work that it opens the way for something still better", an earnest plea is made for the establishment of an institute of microbiology. The answer is to be found in bacterial metabolism. When a bacteriologist discovers an antibiotic in a mould, the chemist should try to isolate the active substance, and if necessary, alter its structure to extract the toxic elements. Team work of this order can flourish only in an institute such as Sir Alexander has in mind.

**Technique in Trauma** Planned Timing in the Treatment of Wounds including Burns. From the Montreal General Hospital and McGill University, by FRASER B GURD, M D, C M, and F DOUGLAS ACKMAN, M D, C M, and collaborators.  $10 \times 7$  in. Pp 68 + vii, with 17 illustrations and 3 coloured plates. 1945. London: William Heinemann (Medical Books) Ltd. 15s net.

*Technique in Trauma* is a monograph on the treatment of burns and war wounds emanating from the Montreal Hospital and the University of McGill. Canadian surgery always holds our respect, and the authors, Fraser B Gurd and F Douglas Ackman, as well as the publishers, Wm Heinemann, are to be congratulated on a carefully prepared and well-documented production. Published in 1945, it records the results of treatment by

sulphathiazole emulsion, occlusive compression dressings, and as far as possible unimmobilization. There is a Preface by John Lockwood, and a Commentary by Ralph Fitzgerald, with sections devoted to major and minor burns, the management of burns, and planned timing in the treatment of wounds and infections by the same technique. This book forms a valuable contribution among the many organized schools of thought which originated during the war and were devoted to this subject before the use of penicillin came into general operation. It would seem that the time is ripe for a comprehensive survey of the subject, to record not only the progress that has been made, but to sift the several methods, and pronounce which on the evidence is the most satisfactory for general use.

**Practical Points in Penicillin Treatment** By G E BEAUMONT, D M (Oxon), F R C P (Lond), Physician to the Middlesex Hospital, and K N V PALMER, M B (Cantab), M R C P (Lond), Acting Medical Registrar to the Middlesex Hospital. 7½ × 4½ in. Pp 16 + iv, with 1 illustration. 1946. London J & A Churchill. 1s 6d net.

THIS booklet sets out in a readily accessible form all the information which House Officers and Practitioners need if they are to use penicillin safely and effectively. A brief but comprehensive account is given of the various preparations, how they are dispensed and stored, and exactly how they are administered. Among many valuable hints the clear directions for giving intramuscular injections call for special attention. The clinical applications of penicillin therapy completes a pamphlet the importance of which can scarcely be over-emphasized now that penicillin is easily obtainable by practitioners who have had no opportunity for special training in its use.

**A Complete Outline of Fractures, including Fractures of the Skull** By J GRANT BONNIN, M B, B S (Melbourne), F R C S (Eng). Second edition. 8½ × 5½ in. Pp 658 + xiv, with 712 illustrations. 1946. London. William Heinemann (Medical Books) Ltd. 30s net.

THIS second edition, though still properly entitled an *Outline of Fractures*, is considerably more bulky than the first, from the student's point of view there is virtue in a book which is reasonably small, yet all the additions to this work are to be welcomed as bare necessities if it is to be kept up to date and remain a useful guide to treatment. The importance of early open reduction and fixation when the circumstances demand it is given fresh emphasis, and the possibilities of operative fixation by modern methods are given due consideration.

The influence of war surgery is evident in this edition, but while much of the advice given about the treatment of lacerated wounds is good, the criticism of the local use of antiseptics is overdone, and the objects of wound excision are not quite correctly expounded. It is courageous to include fractures of the skull, and the author is well qualified to do so because of his special experience in this field. On the other hand, the neurological part of this chapter is too long, requires rearrangement to make it more understandable by the student, and ought to be brought more into harmony with the now generally accepted views about cerebral concussion.

Mr J B Barron's contribution on fractures of the face and jaw is admirable, and the appendices, which include disability tables, surgical exposure of the long bones, and a scheme for the organization of a fracture clinic, present valuable information in a form which is easily available to the student who may have difficulty in consulting the original sources.

The book can be warmly recommended for the help it affords both to those working for examinations and to

practitioners. But in addition it records the experience and opinions of a thoughtful and progressive surgeon who can profit from the criticism of his colleagues. The references to the literature of fracture treatment are well chosen, and are therefore of real assistance to any who seek more detailed information.

**The Renaissance and Its Influence on English Medicine, Surgery, and Public Health** By Sir ARTHUR SALUSBURY MACNALT, K C B, M D, F R C P, F R C S. Being the Thomas Vicary Lecture. 8½ × 5½ in. 32 pp, with 4 reproductions. 1946. London. Christopher Johnson. 5s net.

THIS small monograph contains the Thomas Vicary Lecture which was delivered at the Royal College of Surgeons of England in November, 1945.

The author gives an excellent account of medical men in the sixteenth century and their royal patients. Thomas Vicary lived in an interesting age in which Linacre, Erasmus, Dean Colet, Sir Thomas More, Sir Thomas Elyot, and Andrew Boorde held the stage.

**A Manual of Tomography** By M WEINBRENN, B Sc, M R C S, L R C P, F F R, D M R E, Lt-Col S A M C, Adviser in Radiology, Union Defence Force, Radiologist, Chamber of Mines Hospital, Johannesburg. 9½ × 7½ in. Pp 270 + viii, with 397 illustrations in 138 figures. 1946. London. H K Lewis & Co Ltd. 45s net.

THE author has written this book primarily for those who have no knowledge or experience of tomography. The technique is described and examples given of many cases in which tomography was of value in supplementing the routine radiological examination. The value of tomography in conditions of the lung is well known in this country, but other applications of the method, particularly in the radiological examination of the spine and other bones, are probably not as familiar here as they should be. The author describes many cases in which it was possible to demonstrate fractures or sequestra in the spine and other bones, which were not seen on routine radiographs. He does not give a critical survey of the value of the method to the surgeon, but contents himself with describing a number of cases in which tomography brought to light features invisible on routine radiographs.

**The Principles of Anatomy** An Introduction to Human Biology. By A A ABBIE, M D, B S, D Sc (Syd), Ph D (Lond), Elder Professor of Anatomy and Histology in the University of Adelaide. Second edition, revised and enlarged. 8½ × 5½ in. Pp 273 + x, with 76 illustrations. 1946. Sydney and London. Angus & Robertson Ltd. 12s 6d net.

THIS is a very remarkable book. It was originally written to show how biology could be taught as well from the human as from any other animal, but it has such solid foundations, the details have been so clearly filled in, and the illustrations are so informative that this second edition now contains all that the well-trained medical man knows of human anatomy. Yet it is in no sense of the term a 'cram' book, and the author's intention is that it shall act as an introduction to rather than as a text-book of human anatomy.

By wise choice and skilful presentation of his subjects Professor Abbie has shown how the essentials of anatomy can be offered to the student in a form which is less bulky and more easily assimilated than the standard text-books. Since it seems to be necessary to teach a lot if a little is to be learnt, the big books will no doubt remain with us indefinitely, but it is to be hoped that this book may give further support to the present tendency to relieve the student of an unnecessarily heavy burden in his pre-clinical years.

**The Principles of Neurological Surgery** By LOYAL DAVIS, M S, M D, Ph D, D Sc (Hon.), Professor of Surgery and Chairman of the Division of Surgery, Northwestern Medical School, Chicago, Illinois. Third edition, thoroughly revised  $9\frac{1}{2} \times 5\frac{1}{2}$  in. Pp 540, with 348 illustrations and 5 plates. 1946. London: Henry Kimpton. 37s 6d net.

It is only four years since the second edition of this monograph appeared, yet in that intervening period a large amount of new work has appeared in the realm of neurological surgery. There has been much new and experimental work on the mechanics of craniocerebral injuries and the practical lessons which have accrued from the second world war are far-reaching in their importance.

The new third edition has been very thoroughly revised and brought up to date and can be recommended as a most useful book for students and post-graduates who wish to study neurological surgery.

**The Surgical Clinics of North America** National Number, October, 1946. Symposia on Aseptic Surgical Technique and its Application to Thoracic Surgery, Gastrointestinal Surgery, and Genitourinary Surgery.  $9 \times 6$  in. Pp 269 + vi, with 93 illustrations. London and Philadelphia: W B Saunders Co. Annual subscription (six numbers), paper 55s, cloth 75s.

This volume contains symposia on antiseptic surgical technique, gastro-intestinal surgery, and genito-urinary surgery. Each symposium contains about six articles covering each subject.

The article on the historical aspects of aseptic surgical technique is well written and illustrated. The value of ultra-violet irradiation of the air of the operating theatre

is stressed. The importance of pre-operative skin preparation is discussed at length as it is considered to be the weakest link in the chain of sterile surgical technique.

Other articles are concerned with chest injuries, plastic surgery of the breast, penetrating wounds of the abdomen, anastomosis of the colon, tests for renal function, and the pathology of genito-urinary neoplasms.

This volume contains some stimulating and interesting articles which should prove of real value to surgeons.

**Further Studies in Encephalography** By E GRAEME ROBERTSON, M D (Melb), F R C P, F R A C P, Neurologist, Royal Melbourne Hospital, etc.  $9\frac{1}{2} \times 7\frac{1}{2}$  in. Pp 104 + x, with 54 illustrations, many as plates. 1946. Melbourne: Macmillan & Co Ltd. 35s.

It was only in 1941 that the author of this book published his well-known monograph on Encephalography, and since that date he has not only perfected his technique but also his diagnostic powers.

The present volume, which is dedicated to Dr Gordon Holmes, contains a wealth of information on experimental studies and clinical studies in ventricular filling.

The factors which may prevent ventricular filling are well discussed and the importance of correct posture is stressed.

The radiographs, which are numerous, are of a high order and greatly enhance the written word.

There can be no doubt whatever that if encephalography is improved still further it will entirely eliminate ventriculography.

This book will interest the neurologist, neurosurgeon, and the radiologist, for it contains new facts and new ideas.

## BOOK NOTICES

*[The Editorial Committee acknowledge with thanks the receipt of the following volumes. A selection will be made from these for review, precedence being given to new books and to those having the greatest interest to our readers.]*

**Human Torulosis** A Clinical, Pathological, and Microscopical Study, with a Report of Thirteen Cases. By LEONARD B COX, M D (Melb), M R C P (Edin), F R A C P, Hon Neurologist, the Alfred Hospital, Melbourne, Lecturer in Neuropathology, University of Melbourne, and JEAN C TOLHURST, M Sc (Melb), Senior Bacteriologist to the Alfred Hospital, Melbourne.  $9\frac{1}{2} \times 7\frac{1}{2}$  in. Pp 149 + xi, with 67 illustrations and 15 plates. 1946. Melbourne: Melbourne University Press (London: Oxford University Press). 25s net.

**Physics for the Anaesthetist** By R R MACINTOSH, M A, M D, F R C S, D A, Nuffield Professor of Anaesthetics, University of Oxford, etc., and WILLIAM W MUSHIN, M A, M B, B S, D A, First Assistant, Nuffield Department of Anaesthetics, University of Oxford, etc.  $8\frac{1}{2} \times 5\frac{1}{2}$  in. Pp 235 + viii, with 282 illustrations. By Miss M McLARTY. 1946. Oxford: Blackwell Scientific Publications Ltd. 30s net.

**A Synopsis of Surgical Anatomy** By ALEXANDER LEE MCGREGOR, M Ch (Edin), F R C S (Eng), Surgeon, Johannesburg General Hospital, Lecturer on Surgical Anatomy, University of Witwatersrand. With a Foreword by Sir HAROLD J STILES, K B E, F R C S (Edin). Sixth edition.  $7\frac{1}{2} \times 4\frac{1}{2}$  in. Pp 714 + xvi, with 699 illustrations. Bristol: John Wright & Sons Ltd. 25s net.

**A Descriptive Atlas of Radiographs** An Aid to Modern Clinical Methods. By A P BERTWISTLE, M B, Ch B, F R C S (Edin). Sixth edition.  $9\frac{1}{2} \times 7\frac{1}{2}$  in. Pp 606 + xxix, with 948 illustrations. 1946. London: Henry Kimpton. 45s net.

**A Short Handbook of Practical Anaesthetics** By HOEL PARRY-PRICE, M R C S, L R C P, D A (R C S), Late Senior Anaesthetist, Royal Berkshire Hospital, Anaesthetic Specialist to the Royal Navy, Surgeon Commander, V D, R N V R. With a Foreword by Sir CECIL WAKELEY, Consulting Surgeon to the Royal Navy.  $7\frac{1}{2} \times 4\frac{1}{2}$  in. Pp 127 + viii, with 50 illustrations. 1946. Bristol: John Wright & Sons Ltd. 12s 6d net.

**Urologic Roentgenology** By MILEY B WESSON, M D, Ex-President, American Urological Association. Second edition, thoroughly revised.  $9\frac{1}{2} \times 5\frac{1}{2}$  in. Pp 259, with 258 illustrations. 1946. London: Henry Kimpton. 27s 6d net.

**The Centennial of Surgical Anesthesia** An Annotated Catalogue of Books and Pamphlets bearing on the Early History of Surgical Anesthesia. Exhibited at the Yale Medical Library, October, 1946. Compiled by JOHN F FULTON, M D, and MADELINE E STANTON, A B.  $9 \times 6$  in. Pp 102 + xv, with Frontispiece. 1946. New York: Henry Schuman. \$4.00.



**A Memoir to the Academy of Sciences at Paris on a New Use of Sulphuric Ether** By W T G MORTON, of Boston, in the U S A Presented by M ARAGO in the Autumn of 1847 With a Foreword by JOHN F FULTON 9 x 6 in Pp 24 + vi 1946 New York Henry Schuman \$1 50

**The Pathology of Traumatic Injury** A General Review By JAMES V WILSON, M D, M R C P (Lond), Major, R A M C (T) Pathologist to Harrogate and District Hospital and the Royal Bath Hospital, Harrogate With a Foreword by PHILIP H MITCHNER, C B, C B E, T D, M D, M S, F R C S D Ch, K H S 9½ x 6½ in Pp 192 + xii, with 61 illustrations 1946 Edinburgh E & S Livingstone Ltd 20s net

**Urgent Surgery** Edited by JULIUS L SPIVACK, M D, LL D, Associate Professor of Surgery, University of Illinois College of Medicine, etc 9½ x 6½ in Volume I Pp 714 + ix, with 244 illustrations, 14 in colour 1946 Springfield, Ill Charles C Thomas \$10 00

**Early Ambulation and Related Procedures in Surgical Management** By DANIEL J LEITHAUSER, M D, F A C S, Chief of Surgery, St Joseph Mercy Hospital, Detroit, Michigan 9 x 6 in Pp 232 + xi, with 36 illustrations 1946 Springfield, Ill Charles C Thomas

**L'Osteosynthese au Clou** By R SŒUR, Chirurgien-Adjoint des Hopitaux de Bruxelles 9½ x 6½ in Pp 132, with 134 illustrations 1946 Paris Masson et Cie 325 fr

**Minor Surgery** (Heath Pollard Davis Williams) For the Use of House Surgeons, Dressers, and Junior Practitioners By CECIL FLEMMING, O B E, M Ch, F R C S, Surgeon, University College Hospital With a chapter on The Administration of Anæsthetics by H N WEBBER, B Ch, D A, Anæsthetist, University College Hospital Twenty-third edition 7½ x 4½ in Pp 406 + viii, with 209 illustrations 1946 London J & A Churchill Ltd 14s net

**Ambulatory Proctology** By ALFRED J CANTOR, M D, Associate Proctologist, Kew Gardens General Hospital, Long Island, New York With a Foreword by BEAUMONT S CORNELL, M D, Editor, *American Journal of Digestive Diseases* 9 x 6½ in Pp 524 + xviii, with 281 illustrations 1946 London Hamish Hamilton Ltd 42s net

**Renal Diseases** By E T BELL, M D, Professor of Pathology in the University of Minnesota, Minneapolis Minnesota 9½ x 5½ in Pp 434, with 115 illustrations and 4 coloured plates 1946 London Henry Kimpton 35s net

**The Chemistry of Anæsthesia** By JOHN ADRIANI, M D, Director, Department of Anæsthesia, Charity Hospital of Louisiana at New Orleans, etc 8½ x 5½ in Pp 530 + ix, with 45 illustrations 1946 Oxford Blackwell Scientific Publications 35s net

**Confrontations radio-anatomo-cliniques** Publiées sous la direction de M CHIRAY, R-A GUTMANN, et T Seneque Fascicule I 12½ x 9½ in Pp 56, with 98 illustrations 1946 Paris G Doin et Cie, Masson et Cie 370 fr

# THE BRITISH JOURNAL OF SURGERY

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## INJURIES OF PERIPHERAL NERVES IN TWO WORLD WARS\*

By W ROWLEY BRISTOW

### SYNOPSIS

1 The influence of Robert Jones on the surgery of peripheral nerves

2 The position of peripheral nerve surgery before 1914, during the 1914-18 war, and in the years which immediately followed The lessons learned

3 Surgery in the 1939-45 war, with analysis of 2600 cases Primary and secondary suture The organization Method of recording neurological recovery in sensation and motor power—sponsored by the Medical Research Council

4 Survey of results of sutured nerves January, 1941-January, 1946 Nerve-grafting—the present position Reasons for imperfect results

5 Functional results and lessons to be carried into civil practice

### INTRODUCTORY

Robert Jones, in whose honour this Lecture was founded, died in January, 1933, nearly fourteen years ago, and I would like to commence by recalling to your memory something of the man and his work.

The whole story of his life is told in a beautifully written biography by his son-in-law, Frederick Watson (1934). Watson wrote with knowledge and understanding, and his book is a delight to read.

Qualified at the age of 21, Jones joined his uncle, Hugh Owen Thomas, who was carrying on an enormous practice in the dock area of Liverpool, at 11, Nelson Street. This warren of a house, consisting of numbers of small rooms and cubicles, was a Mecca for surgeons, especially those from the States and from the Continent. It was totally destroyed in the 'blitz' on Liverpool in the spring of 1941, and is replaced by a heap of rubble, and all the interesting records are lost.

Jones learned the principles and practice of surgery from Thomas, and serves as an outstanding example of the great advantages of the old system of apprenticeship, where his opportunities were never ending for acquiring all that the master had to teach. He made the most of these opportunities, and he did what Thomas could never do, he made those principles and that practice part of British surgery.

At the age of 31 he was appointed Surgeon-Superintendent, to organize and control the chain of hospitals which were improvised to provide an

accident hospital service for the great industrial undertaking, the building of the Manchester Ship Canal. Some 20,000 navvies were employed. In retrospect this appointment was providential, for



SIR ROBERT JONES

when the opportunity came with the war of 1914-18, he was fitted by knowledge and experience, as well as by temperament and personality, to play the great part which he did play in the care of the wounded soldier.

When, by the late autumn of 1914, our casualties were enormous and the wounded were crowding into the home hospitals from the Battle of the Marne,

\* Being the Robert Jones Lecture delivered at the Royal College of Surgeons of England on Dec 12, 1946  
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following the Mons retreat, from the Aisne and from Ypres, Jones saw the problem in its entirety and found the solution in the formation of the Orthopaedic Centres. Writing in defence of these later to Makins, he says —

During the first twelve months of the war no provision of any sort was made for cases crippled and deformed, and early evacuation was both the instruction and the routine. The result was that many men were discharged from the Army in a very large number of cases totally unfitted either for military or civilian life. These men promised to become foci of seething discontent and at that time a menace to successful recruiting.

Sir Alfred Keogh, the then Director-General, sent for Robert Jones and it was arranged that 250 beds should be allocated to him in Alderhey in Liverpool as a trial. Shepherds Bush opened in the spring of 1916 and finally some 30,000 beds were set aside in the Orthopaedic Centres, and patients were not discharged until all that could be done for them was done.

For patients to be segregated into the Orthopaedic Centres, it was essential that the type of disability comprised within the term must be defined. In addition to fractures and diseases and injuries of joints, peripheral nerve injuries were included. This was a wise inclusion, for operation, if indeed operation is called for, is but an incident, albeit an important one, in the care of the patient. The Centres, with their long-stay privilege, their complete physiotherapy and rehabilitation sections, including curative workshops, were well staffed by a team of which a neurologist was a key member.

Robert Jones's influence on the problem of peripheral nerves was first and foremost, then, in organization and planning for the segregation of these patients under a staff equipped to deal with them.

He had always been interested in the clinical side, and in 1906, with Warrington, of Liverpool, had published in *The Lancet* a paper entitled "Some Observations on Paralysis of the Brachial Plexus", and gave the opinion that mechanical treatment should be thoroughly persevered with before having recourse to operation. In this paper the literature is reviewed, and there are many references to the work of Sherren, Kennedy, and Spitzky of Vienna. Nerve transplantation, anastomosis, and grafting are discussed.

An interesting sidelight on his early association with Thomas is forthcoming when he outlines the after-treatment of these injuries.

He writes —

The muscle should be systematically and energetically massaged. In the case of the poor who cannot afford a masseur, a small gutta-percha ball transfixed by a skewer and placed in a handle will render good service.

His interest was largely centred in the somewhat similar problem of infantile paralysis. He preached and practised and taught the need for relaxation of paralysed muscles by appropriate splintage, the need to avoid deformity caused by the continued action of the non-paralysed opponents or by gravity. In order to bring home the lesson he stressed that never for a single moment must the paralysed muscle

be stretched—splintage must be efficient, prolonged, and constant.

Then again he contributed to the problem of the means for restoration of function when the paralysis is permanent. His experience was unique among his contemporaries, and much of the work was but little known outside Liverpool. Jones's pre-war reputation was far greater both in the States and on the Continent than in his own country, and his great ability far more appreciated. It is fair to say that not until the war did he take his rightful place as an acknowledged leader of British surgery, and the master in that field which he had made his own. Of the many operations he designed and practised, perhaps the complete tendon transplantation for musculospiral palsy has the greatest vogue at the present day.

In 1919, when visiting the States with Anthony Bowlby, he presented a paper to the Clinical Congress of the American College of Surgeons (1920) entitled "Joint, Nerve, and other Injuries in War Surgery", and his review of the treatment of peripheral nerve injuries is clear, concise, and accurate.

As one who by force of circumstance has been very much concerned with the problem of peripheral nerve surgery in the two wars, I have chosen this subject for the Robert Jones Lecture.

Previous to the war of 1914-18 there was but little helpful literature on the surgery of peripheral nerves, the outstanding contributions being Weir Mitchell's *Injuries of Nerves and Their Consequences* (1872) and Sherren's monograph, published in 1908, as the result of his work with Head. It will be remembered that Sherren divided and sutured Head's radial nerve, and partly as the result of this human experiment, Head's theory of cutaneous sensation was formulated, based on his conception of epicritic, protopathic, and deep sensibility. These terms were in common use and appear in the voluminous literature on the subject which followed the war years.

The term protopathic has been finally discarded. I do not propose to enlarge on the theories of cutaneous sensibility, as this has been done in a brilliant review by Walshe, published in *Brain* (1942), in which he discusses the various reasons which render Head's theory untenable. Head postulated a second set of sensory nerves which had no foundation in any known structure, and the work of Woollard and later of Weddell on the anatomy of the sensory nerves finally assisted to disprove his theory.

Charles Ballance and Purves Stewart had also written on the subject, and Ballance's work on facio-hypoglossal anastomosis is well known. Kennedy, of Glasgow, had operated on a considerable number of birth injuries of the brachial plexus and was somewhat more optimistic than his contemporaries or the later generations of surgeons.

But viewed broadly, peripheral nerve surgery was a new and largely unexplored field, there was little authentic information obtainable, and still less knowledge of what was to be expected in the way of end-results.

As already told, when discussing Robert Jones's work and influence, by 1916 the wounded with peripheral nerve injuries were segregated and dealt

with in selected centres, as part of the orthopaedic organization which he founded and controlled. In addition to one's colleagues in the orthopaedic group of that time, there are names to be remembered in connexion with this—amongst others, one may mention Stiles, of Edinburgh, Wilfred Trotter, Percy Sargent, and Joyce, of Reading. Wood Jones's (1921) description of trick movements and Stopford's review (1920) of intermediate results, were noteworthy contributions.

In 1920 the Medical Research Council published *The Diagnosis and Treatment of Peripheral Nerve Injuries*, compiled by the Committee upon Injuries of the Nervous System, under the Chairmanship of Farquhar Buzzard. This report was reprinted in Canada in 1942, and is still the standard work on the subject. The other outstanding contribution is the section on operative treatment, written by Stiles, in Jones's *Orthopaedic Surgery of Injuries*, published by the Oxford University Press in 1922.

It will be remembered that Stiles was a superb anatomist and had written the section on surgical anatomy in 'Cunningham'. His detailed description of the surgical approaches and exposure is masterly, as witness the exposure of the sciatic at the notch by reflection of gluteus maximus from below upwards, the finding of the radial nerve between brachio-radialis and brachialis anticus by tracing the cutaneous branch upwards until it joins the parent trunk, or the retraction of the neuro-vascular bundle medially in exploring the radial as it enters the humeral groove.

In 1923 Professor Harry Platt and I were detailed to present the British Report on this subject at the International Society of Surgery, at its meeting in London. The available statistics were somewhat meagre, and there is no statistical record of the results of the vast number of patients who were operated upon. No late follow-up showing true end-results on a large scale was possible.

In the main our conclusions, which were based largely on impressions, have proved to be correct. End-to-end suture was stressed as the one operation likely to yield results when operating on a divided nerve. Various operations for overcoming a gap, described and illustrated in the text-books of the time, were tried and finally condemned—amongst others in this category may be mentioned—

Neuroplasty, or the turning down of a flap from the proximal to the distal stump.

Tubulization, the joining of the divided ends by a sheath of fascia, vein, or some foreign material such as Cargile membrane.

Nerve-grafts, which, although in a few instances they showed some degree of recovery, were in the main failures.

The final assessment of the value of nerve-grafts in the 1914 war was that if no other means of joining the nerve was practical, a graft should be employed. If a graft was used then an autogenous cable graft was advised.

I shall refer to the present position regarding nerve-grafts when considering the 1939-45 war, but at that time there was a general impression that a graft was an alternative to suture, and both homogenous and heterogenous grafts were employed. It seemed necessary to stress the point that the

surgeon must exercise all his ingenuity to endeavour to join the nerve end to end and that grafting was not an alternative operation but only to be used as a last resort.

In the final survey it was pointed out that neurological recovery always fell short of perfection—generally a very long way short, but that the result of nerve suture, viewed from the standpoint of function, gave reasonable results in many instances.

The pre- and post-operative treatment, and the treatment of the lesion recovering without operation, was systematized. We learned the importance of preserving joint mobility, especially that of the smaller joints in the hand and foot, a lesson which definitely had to be re-learned in 1939. We learned, too, the methods of overcoming fixed deformity. This was comparatively simple in the bigger joints, but was difficult in the hand. We learned that forced manipulation under anaesthesia followed by activity was useless for the stiff metacarpo-phalangeal range, or for the joints of the fingers. Many ingenious devices were implemented by elastic or spring traction, by wedging with malleable splints, or by the use of plaster for overcoming fixed deformity in these small joints. Splints were used to relax paralysed muscles, the shoulder abduction splint in plexus injuries and the "Shepherds Bush glove" for radial nerve palsy (Figs 484-487). A toe-raising spring replaced the paralysed dorsiflexors of the foot in lateral popliteal paralysis. Splintage, however, was minimal, always provided the principle that the paralysed muscle must be held relaxed was followed.

The after-treatment by physiotherapeutic methods was carried out efficiently and more continuously than in the war of 1939. Heat, massage, interrupted galvanic stimulation, and finally, with recovery, faradism and exercises were the general routine. It was clearly stated that although these measures had no effect on regeneration of nerve, they preserved and kept up nutrition in the limb.

There is a difficulty in practice in carrying out this programme of rehabilitation. It is easy so long as the man is in hospital or convalescent centre. In Shepherds Bush and its annexes many of these men remained for months and spent their time in the curative workshops attending the specialized therapy departments for daily treatment. The man-power shortage did not appear as extreme as in the 1939 war, and I am under the impression this time that there is less specialized physiotherapy and that the men go back to a trade or to work and avoid daily visits to treatment centres.

Whether they, in fact, lose much by so doing is hard to say. The value of interrupted galvanism must be weighed against the economic factor—the loss of time and work during their attendance or in transit to hospital or clinic. Galvanism seemed to make for less wasting and the experimental work of Guttmann and others suggest that the wasting is definitely less. Again, galvanic stimulation had some value on the psychical side because for a patient to see the paralysed muscle in action and the joint moved by his own muscle is a stimulus. Therefore, my personal view would be that there should be careful selection of patients and that some who are keen to work and whose functional disability is

minimal, as with a low ulnar lesion, should be encouraged to work, and that for them prolonged after-treatment is unnecessary. There is much that they can do in productive industry or even in the Services if the man-power position demands it and reinforcements are few, as at times in the Middle East.

The various operations to improve function in dealing with the problems afforded by irreparable nerve lesions were based on, and are similar to, those already practised in the treatment of the

of that period, if one may use the term, lay in the poorness of the note-taking and recording and the difficulty of obtaining a long enough follow-up of the patients.

Looking back and comparing the surgery of the war of 1914-18 and of the years which immediately followed with the surgery of the present war, it is doubtful whether there has been any great advance in technique or in operative skill which would lead us to expect an improvement in results.

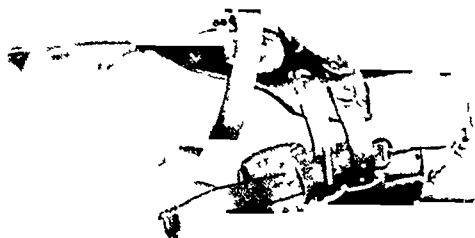


FIG 484 —Shepherd's Bush glove, with elastic accumulators replacing extensor tendons. Extended position.



FIG 485 —Flexed position.



FIG 486 —Brian Thomas modification of Fig 484, extended position. Note finger tips are uncovered.



FIG 487 —Flexed position.

disabled limb following infantile paralysis. Robert Jones was a pioneer in this work. His tendon transplantation for radial nerve palsy will be discussed when we are considering the results of suture of that nerve, and is still the standard practice.

Tenodesis, e.g., converting the paralysed dorsiflexors of the foot into a suspensory ligament, for paralysis of the lateral popliteal was tried, but abandoned as the newly-formed ligament stretched and allowed the foot again to drop.

Certain other simple procedures, such as Bier's subcutaneous elongation of the tendo Achillis for fixed equinus, and excision of a dorsal bone wedge for fixed flexion deformity of the interphalangeal joint of the great toe, a not uncommon consequence of a divided sciatic, were practised and still have their place in reconstructive surgery.

These, then, are some of the lessons we learned in the 1914-18 war and, like other happenings of that time, they had to be, in part at least, re-learned when peripheral nerve surgery again became a major problem some twenty years later. The failure

Brief mention is called for in regard to certain advances which have been made. In a personal communication, Bauwens describes the advances in electrical testing as follows —

The excitability of muscles gives some useful indications as to the state of the muscles' innervation, and can, therefore, indirectly give information of diagnostic and prognostic value in motor nerve lesions.

Quantitatively this excitability can be expressed as a curve called the intensity-duration curve.

When dealing with a muscle in which all fibres have the same characteristics of excitability—all normal or all denervated—one or two points on this curve will give all the information necessary, particularly when the type of response is also taken into consideration (sluggish or brisk reaction to interrupted galvanism). In these cases investigation with faradism and galvanism suffices.

When a muscle consists of a mixture of fibres with different characteristics of excitability—as in partial lesion or during recovery—the intensity-duration curve becomes the resultant of two curves.

Recovery, which means an increase in the ratio of normal to denervated muscle-fibres, is indicated by a

modification of the shape of this resultant curve. It follows that the greater the number of measurements taken in order to plot the curve, the more reliable can be the deductions drawn.

In practice, the reconstruction of curves from three measurements of the current for durations of  $\frac{1}{1000}$  of a second,  $\frac{1}{50}$  of a second, and 1 second, proved adequate, without being technically tedious.

*Table I*  
(January, 1941, to December, 1945)

Total number of patients	2082
Total number of peripheral nerve lesions	2636
Nerves involved —	
Brachial plexus	123
Medians	451
Ulnars	664
Radials	321
Dorsal interosseus	85
Musculo cutaneous	21
Axillary	25
Internal popliteal	426
External popliteal	520

segregation and treatment of these patients. There are three main centres in England and two in Scotland, and the majority of the work has been carried out in these centres. The work done at one centre, that at Pyrford and Botley's Park, for the London area, is shown in *Tables I, II*.

A peripheral nerve injury, in war at least, is seldom an isolated lesion, for there is usually gross associated damage to muscle, tendon, blood-vessels, or bone. The injury, then, is a complicated one, and special experience of the surgery of the extremities is required by the surgeon handling the problem.

### TECHNIQUE

I do not propose to enter into details of operative technique, and would only remind you that the lessons learned in the 1914 war were put into practice. These include the widest anatomical exposure, altera-

*Table II*  
(Jan 1, 1941, to Dec 31, 1945)

OPERATIONS	SUTURE	NEUROLYSIS	BULB SUTURE	GRAFTS	IRREPARABLE	TENDON TRANS-PLANTATION
Median	114	58	2	2	3	—
Ulnar	212	53	—	—	8	—
Radials	57	21	—	—	23	30
Dorsal interosseus	4	—	—	—	—	16
Musculocutaneous	2	—	—	—	1	—
Internal popliteal	71	62	1	3	11	—
External popliteal	106	55	—	—	17	—
Total	566	249	3	5	63	46

The use of electromyography is another definite advance and yields information which cannot be obtained in any other way. Although not required in the ordinary routine examination, it must be available to solve a difficult problem. The sweat test also forms a valuable check and has been largely employed. In technique, the use of fibrinogen plasma as a suture material has a definite if limited value. Much work has been done on the histology and pathology in relation to the nerve gap and regeneration and many papers have been published, mainly from the Oxford Centre.

It is good to be able to say that during the 1939-45 war the Medical Research Council Committee, this time under the Chairmanship of George Riddoch, has not only systematized the note-taking and recording, but with the greatest co-operation from the Ministry of Pensions, has established an efficient follow-up system. The Ministry, to their lasting credit, have sanctioned payment both for travelling and lost working hours to the men who attend at the necessary intervals. By this means, a wealth of records of vast importance is being accumulated. The follow-up will continue till 1949, so that for many patients, at least, a five-year follow-up is envisaged, the man being seen and assessed at the centre nearest his home, and not necessarily at that at which he was treated originally. This serves as a useful check and disarms the criticism which might be levelled at a surgeon assessing his own results.

In the 1939-45 war, under the E M S, an organization similar to that of 1914 was planned for the

tions in posture of the limb, stripping up of branches, and transposition for the ulnar and rarely for the musculospiral. Bulb suture, the two-stage operation, and bone shortening will be needed at times, usually for the median or medial popliteal.

Suture of the sheath only with the finest thread or stainless steel wire is the general practice. The protection of the suture line by wrapping was tried in the 1914 war, and given up, and was not practised, as a rule, by our surgeons in the recent war. The Americans used tantalum foil as a protective wrapping and were enthusiastic as to its value. Certainly some of them have given it up and Stirling Bunnell states that he spends much time in removing it. Our experience is that any form of wrapping increases fibrosis round the nerve and is best avoided.

**Primary and Secondary Suture**—The question of the advisability of primary suture has given rise to a great deal of discussion both in our own country and in the United States.

The problem seldom arises in war surgery. There is neither the time nor the equipment available to a surgeon in a Field Surgical Unit or a Casualty Clearing Station during an active phase. It is argued that even when both are available, it is better to delay. There are two main reasons for this advice. First, and more important, immediately following an injury, other than a clean cut with a knife, it is impossible to know how much of the nerve proximal to the point of division has been injured, and therefore the surgeon cannot know how much he should resect in order to expose healthy bundles. Secondly, the Schwann cells in the distal

stump, which play a considerable part in the union of the divided ends, take some time to exhibit maximum function. According to Young (1942) from about the second-third week is the optimum time. If a nerve is divided by a clean cut or inadvertently at operation it should be sutured immediately, as the damage to the proximal stump met with in wounds caused by high-velocity bullets or in severe crushes does not arise.

Spurling and Woodhall (1946) have published some figures bearing on this point. They record that they have found 22 per cent of failure in primary sutures, compared with only 5 per cent failure in the early secondary suture, but the follow-up is too short to be of any real value.

In the repair of a digital nerve, an important and fairly common operation in civil practice, primary suture will give the surgeon his one chance of affecting direct repair. The freeing and suture of a divided digital nerve in scar tissue following healing is generally impossible and autogeneous grafting will be called for as the alternative.

**Early versus Late Repair**—The whole question of effect of the time-lag between the injury and suture is of interest. Most experienced surgeons advocate early intervention, and this has been the agreed policy in this country. The difficulty arises in carrying it out in practice. In an active campaign the overriding necessity for freeing hospital beds, for evacuation to the permanent base, coupled with the time lost in transport, impose a necessary delay. A patient may spend many weeks, with frequent change of hospital, before he finally reaches the centre.

But we, like the Americans, aimed at early intervention, and during the later part of the Italian campaign a peripheral nerve centre was opened in Italy at Caserta. There, 110 nerves were explored and 60 sutures were carried out with a delay of only some few days or weeks. These patients are being followed up as a group, but they were sutured too recently for inclusion in the present review.

Spurling and Woodhall (1946) have reported 1500 sutures with an average delay of 39 days from wounding. They claim that the nerves were more readily mobilized and that the scarring was minimal, making the operation easier of performance, and they stress the favourable condition of the nerve stump, and of the denervated muscles, shortly after injury.

It should be made clear that although there is some doubt about the relative values of primary and secondary suture, no one advocates delaying the operation of secondary suture, excepting for some very good reason such as the existence of an open wound or sinus. The M R C Report of 1920 says:

"...fortunately such delay has little appreciative effect on the ultimate result", and this statement is largely true. The report is sometimes misquoted or at any rate misunderstood (Cairns and Young, "Treatment of Gunshot Wounds of Peripheral Nerves", 1940), and has given rise to the opinion that delay in repair was considered a matter of no moment.

The follow-up of the sutured nerves from the 1939-45 war is of interest in this connexion. A comparison of the percentage of recoveries with delay of less than, and more than, six months, shows

no difference, excepting with the ulnar and lateral popliteal, where the results appear slightly better following early rather than late secondary suture. It will be obvious that the earlier the suture is done, the less will be the wasting and general change in the limb, no matter how well looked after, and emphasis should be laid on the need for keeping up the nutrition and the joint movements during any period of waiting, however short this period may be.

With nerve lesions complicated by fracture, precedence should be given to operation on the nerve. It may be that internal fixation of the fracture can be safely carried out at the same operation, but apart from this the fracture can be taken care of. An important reason for the policy of attacking the nerve without waiting for the healing of the fracture is that bone shortening may enable the surgeon to effect an end-to-end suture which would be impossible otherwise. To shorten a fractured humerus or femur is simple. To shorten an intact femur, united after months of treatment is a formidable undertaking, at least for the patient.

Neurolysis, or the freeing of the nerve from scar tissue, is the usual accompaniment of any nerve exploration which does not end in suture. The results of this operation recorded in figures or graphs are valueless. In the vast majority the operation makes no difference to recovery. If the nerve goes on to partial or even complete recovery, the result will be assessed in the various tables at a proportionately high percentage, but in all probability recovery would have gone on as completely without operation. In my experience, this operation is of value to relieve pain, when a nerve is anchored about a joint and when each movement of that joint exerts traction on the nerve so fixed. With such patients, the freeing of the nerve-sheath from scar and replacing it in a good muscle bed will generally yield the required result.

It must be remembered that with the syndrome of complete division and a wound in the anatomical course of the nerve, exploration should be regarded as part of diagnosis. If the surgeon finds the nerve intact—physiological division—no harm is done. It is not wise to wait for signs of returning function, and to explore only if these fail to appear.

## RESULTS

The Peripheral Nerve Committee of the Medical Research Council are analysing the results so far obtained in the 1939-45 war, and it is by the kindness of my colleagues on this Committee that I am able to give you some figures derived from the five centres in addition to those of our own centre at Pyrford, from which certain conclusions as apart from impressions may be arrived at.

Anyone who attempts to produce tables and percentages will find he is up against a task of real difficulty. A table by itself showing results good, fair, or poor, is of no value. We must know, and know with some accuracy, the criteria for the findings.

The Medical Research Council criteria for sensory and motor recovery are used in all the centres, so that the records conform to a set standard (*Tables III, IV*).

It is intended in this review to illustrate the degree of recovery in individual nerves in composite

histograms, combining motor and sensory recovery in percentages

To demonstrate the method we have used in arriving at the composite tables, we will examine

Table III—ASSESSMENT OF SENSORY RECOVERY

S 0	Absence of sensibility in the autonomous zone
S 1	Recovery of deep cutaneous pain sensibility within the autonomous zone of the nerve
S 2	Return of some degree of superficial cutaneous pain and touch sensibility within the autonomous zone of the nerve
S 3	Return of superficial cutaneous pain and touch sensibility throughout the autonomous zone, with disappearance of any over-response
S 4	Return of sensibility as in Stage 3, with the addition that there is recovery of 2-point discrimination within the autonomous zone

the histograms of high median division one year after suture (Fig 488) and trace recovery in two or

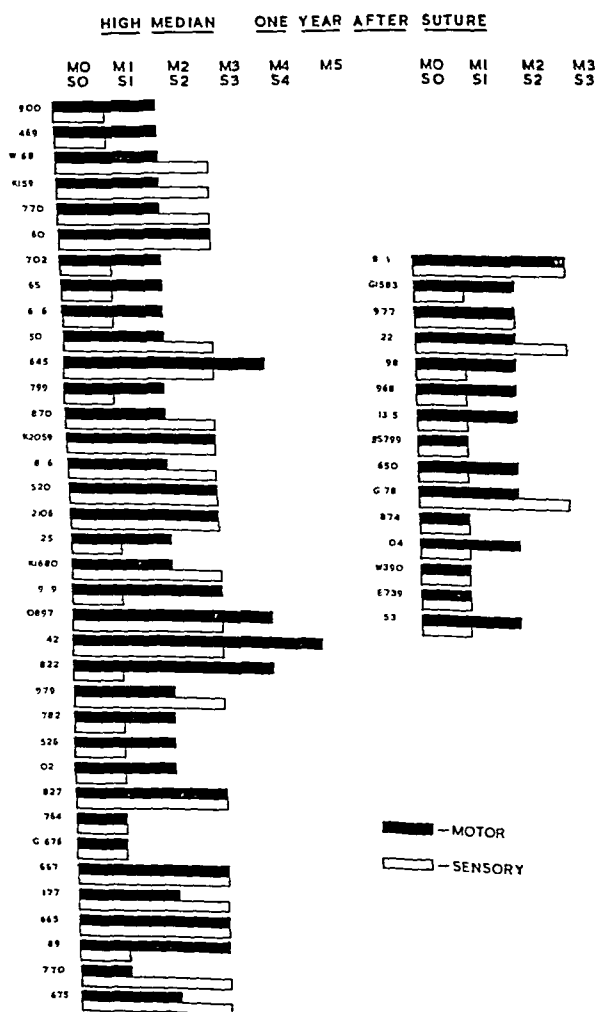


FIG 488—Results of high median suture one year after

three of these patients for 2, 3, and 4 years after suture (Fig 489)

Thus it will be seen that recovery may go on even between three and four years from the date of suture

It will be noted that recovery may reach a point, perhaps quite early, and then remain stationary, and this holds good for either the motor or the sensory

Table IV—ASSESSMENT OF MOTOR RECOVERY

M 0	No contraction
M 1	Return of perceptible contraction in the proximal muscles
M 2	Return of perceptible contraction in both proximal and distal muscles
M 3	Return of function in both proximal and distal muscles of such an extent that all important muscles are of sufficient power to act against resistance
M 4	Return of function as in Stage 3, with the addition that all synergic and isolated movements are possible
M 5	Complete recovery

In assessing the degree of recovery after repair we must make a clear distinction between two standards, the physiological or neurological on the one hand, and the functional or economic on the other. The former represents the degree of restoration of conductivity in the nerve estimated in terms of sensation and motor power, and it will be seen that this falls a long way below normal

In general, it may be stated that the average successful result of suture is restoration of voluntary power in the proximal muscles, and recovery of sensation to pain as elicited by pin-prick and some appreciation of touch. Accurate and localized appreciation of light touch and compass-point discrimination are uncommon and voluntary control

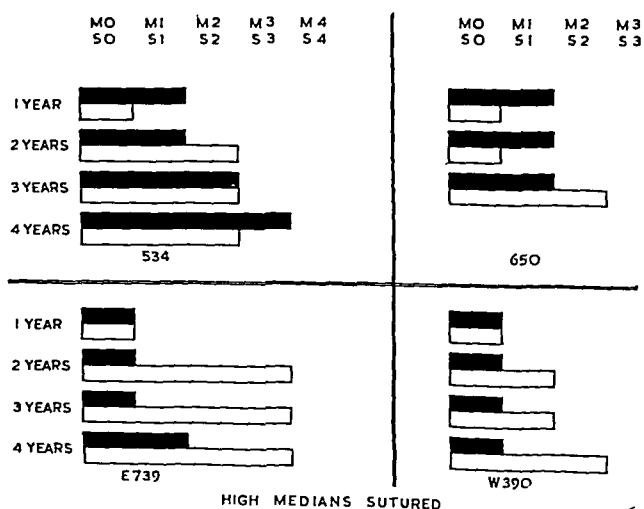


FIG 489—Results in cases of high median suture over a period of 4 years

of the small muscles in the hand is also uncommon, whilst recovery of the foot intrinsics is practically unknown

Thus M 1, S 2 on the table is a common finding. But even this table, worked out after considerable care, is not sufficiently informative. M 1 represents a return of perceptible contraction of proximal muscles only, M 2 a flicker in distal muscles as well. In many instances the proximal muscles recover good power, sufficient to act and move the limb against gravity and resistance, and yet there is no recovery in the distal muscles. Therefore we use



the term M1/3 in our records, meaning good function in proximal muscles, no recovery in the distal, and this formula will be seen in our composite tables

Our percentage figures are not strictly comparable with those of the MRC series, because we are assessing neurological recovery to a certain level of useful function instead of pure neurological recovery

Any estimate from the angle of function must vary with the individual patient and the particular nerve involved. Thus a workman, e.g., a bricklayer, may have good function, whilst still exhibiting the syndrome of the complete division of the ulnar nerve in the forearm. A violinist who has made average or above average recovery following suture may well be 100 per cent failure judged from the economic standard. Similarly an irreparable lesion of the lateral popliteal will put an end to the patient's career as an athlete, as a professional footballer or cricketer, but will be no disability to a man in a sedentary occupation

### RESULTS OF SUTURE

It will be convenient to summarize the results under the more important individual nerves, and it has been shown that early signs of recovery are no criterion that recovery will progress

The best results are seen in children, when the small muscles will recover and something like perfection may be reached

Considering the main nerves individually, we will begin with the most promising, the radial

**Radial Nerve**—The radial nerve in this war, as in the last, heads the list of recoveries, depending as it does on motor recovery almost entirely (Fig 490)

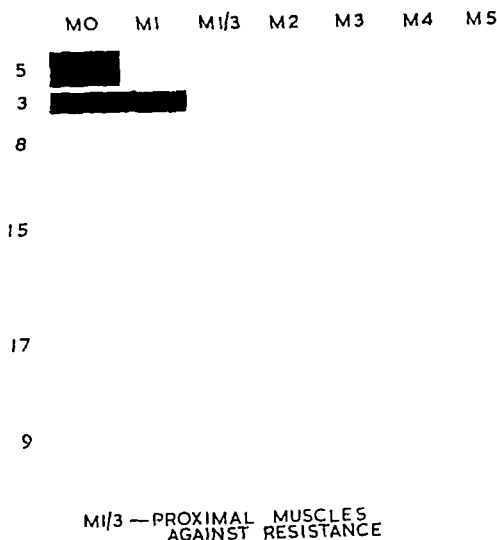


FIG 490—Motor recovery in 57 radials sutured over one year

Of 57 radials sutured at Pyrford, 24 were high sutures—that is, in the groove in the humerus or above—and 33 were low sutures. Following the high suture, recovery will not be evident until over a year from operation, and if an assessment is made earlier, the result will be recorded as a failure, whereas such a patient may go on to adequate recovery. Of 57 sutures, 49 show adequate recovery or better

Our high sutures gave 83 per cent successes, 17 per cent failures  
Our low sutures gave 97 per cent successes, 3 per cent failures

Now this figure looks, on the face of it, too good, but 23 divided radials were regarded as impossible to suture. Put differently, whereas repair of a median is essential to restore sensation in the hand, fingers, and thumb, with a divided radial a tendon transplant is a good alternative and gives a useful hand, so we have not sutured the nerve unless we could get reasonably promising ends

Radial nerve involvement is a common complication of a fractured humerus, open or closed

Of 272 radials, 171 were accompanied by fracture (Table V). Some of these were involved to a minor degree, and indeed 120 recovered spontaneously. With a closed fracture anatomical division of the nerve is rare, and it is wiser to await signs of recovery rather than to explore early

Table V

Radial nerve lesions accompanied by fracture 171			
	Closed	Open	
Recovered spontaneously	17	103	
Sutured	7	25	
Tendon transplant	2	17	
Dorsal interosseous lesions accompanied by fracture 38			
	Closed	Open	
Recovered spontaneously	6	21	
Sutured	—	2	
Tendon transplant	—	9	

**Tendon Transplant for Irreparable Radial Nerve Lesion**—The classical operation designed by Robert Jones is still the routine. I would remind you that he transplanted PRT → ECRL → FCR into ECRB

EOMP and EBP and FCU → the finger extensors and ELP—sometimes palmaris longus was used instead of FCR

This operation gives a good useful hand, with controlled extension of the wrist and fingers, but Zachary (1946) has pointed out that the results are far better if one wrist flexor is present. The standard operation then suffices if the patient possesses a palmaris longus, which stabilizes the wrist when the fingers extend. In those in whom the palmaris longus is absent, Zachary employs FCU for all extensors, including the thumb, leaving FCR as a stabilizing muscle to fix the wrist

One flexor to prevent the wrist from dorsiflexing is of considerable value, and its absence may account for the variations in result sometimes seen. In a sample taken at random of 100 males and 100 females, the palmaris longus was present on both sides in 81 per cent. It was present in right arm only in 4 per cent and in left arm only in 6 per cent. Therefore 8 per cent of patients had no palmaris longus on either side (Table VI)

Table VI—PALMARIS LONGUS

	Men	Women
Present both sides	80	82
Present right only	5	3
Present left only	6	7
Absent both sides	9	8
	100	100
Total—Both present	81	per cent
Right present only	4	per cent
Left present only	6	5 per cent
Both present	8	5 per cent
	100	per cent

In those with palmaris longus absent the wrist will dorsiflex as the fingers and thumb extend, and this interferes with function in certain movements

**Median Nerve**—The degree of recovery shown by the median after suture is better than one expected—always remembering that neurological recovery falls far short of normal

Of 51 high median sutures in the arm, 31 (61 per cent) resulted in adequate motor and sensory recovery (Fig 491)

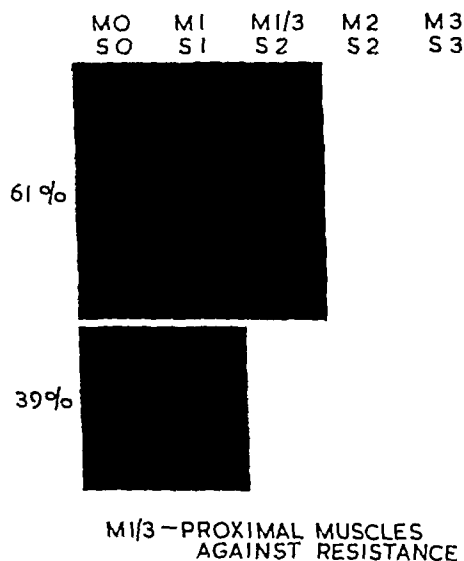


FIG 491—Recovery in 51 high medians sutured over one year

Of the 47 low medians, 30 (64 per cent) reached this grade. It is difficult to estimate motor recovery following a low suture (Fig 492). The anatomical

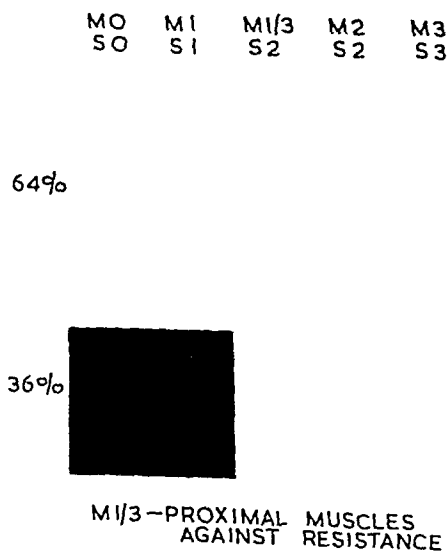


FIG 492—Recovery in 47 low medians sutured over one year

variations in the motor supply to the small muscles of the hand are more common than was thought. The most extreme example was reported to me by Weddell (1946). A patient with complete division of the ulnar had the nerve sutured in the early days

of penicillin. On his return to this country shortly afterwards, he was found to have normal function in all the hand intrinsics, which gave rise to much speculation. However, on blocking the median, all intrinsics were paralysed, and the anatomical variation in supply made evident.

We can say that rather more than half the median sutures, high or low, are successful, in so far as the results are compatible with a safe hand. Of the total of 91, 10 only recovered nearly normal sensation—that is, had no over-reaction.

From the point of view of function, recovery of sensation in the median is all important. A 'safe' hand from the standpoint of cutaneous sensibility means that the patient can appreciate pain, and therefore will no longer be liable to burns from his cigarette or allied injuries. This is something gained, but recovery to this level only leaves the hand much disabled. Most men with a median nerve injury use the opposite hand for common domestic acts, such as doing up a button. They are unable to feel the milled edge of a coin, and they carry their money in their opposite pocket. They rely on the uninjured hand when one hand will suffice for what they are doing.

A divided median, then, will surely leave some degree of permanent disablement and it may well be a severe degree.

**Ulnar Nerve**—The ulnar, with a far smaller autonomous sensory area, is a less severe handicap to the majority when injured than the median.

The M R C figures of recovery following suture of this nerve, with a minimum follow-up of over twelve months and a maximum of three years, show that of 391 sutured ulnars 30 per cent recovered some power in the proximal and distal muscles, more than a flicker of contraction in the 1st dorsal interosseous, but not sufficient to act against gravity and resistance, 13 per cent recovered to good power in all muscles, and 5 per cent were practically normal (Fig 493).

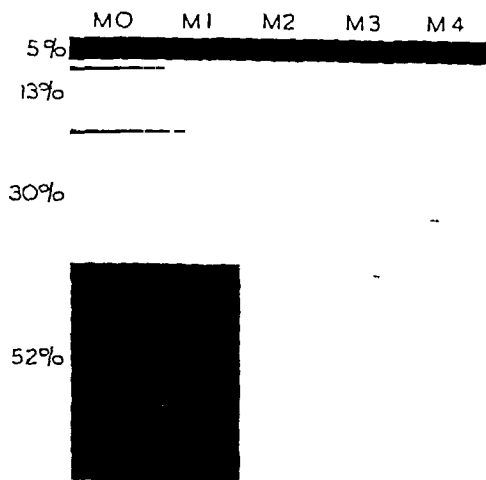


FIG 493—Motor recovery in 391 ulnars sutured over one year

Of 383 sutures, 57 per cent recovered sensation to S 2 or better, which I would remind you means "return of some degree of superficial cutaneous pain and touch sensibility within the autonomous zone" (Fig 494).

The figures from our centre show combined motor and sensory recovery in a composite graph, and are divided into high and low sutures. Of the 88 high, 49 per cent reach M 1/3, S 2 or better, that

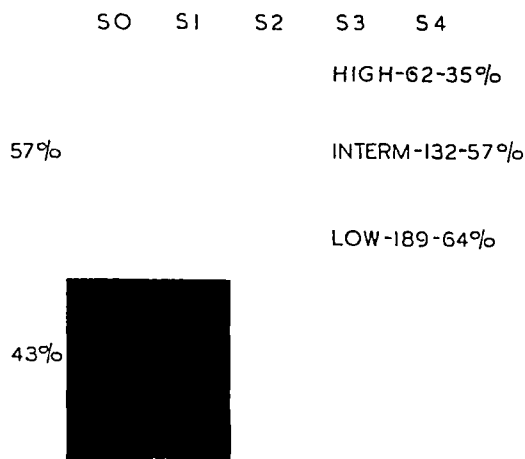


FIG 494—Sensory recovery in 383 ulnars sutured over one year

is adequate recovery, 51 per cent reach M 1, S 1 and are failures, at any rate at present. Some of these, it is fair to say, may show improvement after a further interval (Fig 495). Of the 104 low, 55 per cent are adequate (Fig 496).

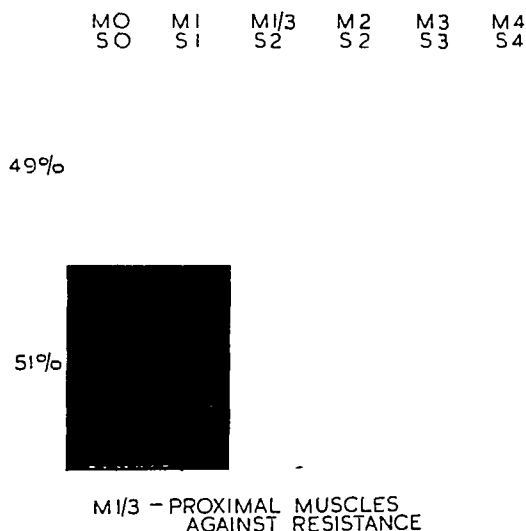


FIG 495—Recovery in 88 high ulnars sutured over one year

The disability resulting from a divided ulnar depends on the occupation of the patient. Many men with no recovery are able to carry on full work and heavy work, such as dock labouring and brick-laying, but when the finer control is needed, as in playing a musical instrument, the patient is seriously handicapped. Equally, precision work such as operating a machine tool will be impossible.

Full neurological recovery is not seen, although a successful suture in a clean cut about the wrist, especially in a child, may result in the restoration of voluntary power in the interosseus.

**The Sciatic**—I cannot do better than quote the generalization from our paper (Platt and Bristow, 1924) —

Here the neurological and economic results have been consistently poor. No case is on record where recovery has been demonstrated in the intrinsic muscles of the foot. The type of sensory restoration has been on the average exceedingly defective, and this has constituted in many patients a source of danger from the tendency to the development of traumatic ulceration in the foot. The earlier and more complete recovery seen in the calf muscles, as compared with the anterior tibial group, has often been instrumental in determining the production of a contracture in patients who have lacked post-operative supervision. As in the case of the median nerve, irritative phenomena are occasionally seen, and add to the serious psychological and physical disablement of the individual.

This summarizes the results of 1914-18 and is a fair summary of the results we are seeing now.

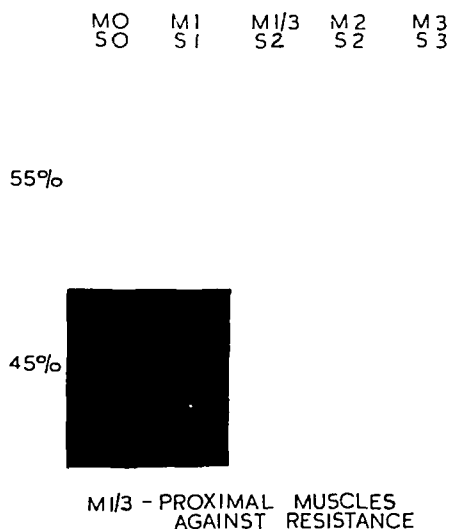


FIG 496—Recovery in 104 low ulnars sutured over one year

It is important to assess ultimate function, because in practice the problem arises. Is this man better off with a below-knee amputation? If sufficient time has elapsed since suture, and there is little or no recovery of sensation in the medial popliteal distribution, if the man has a thin wasted foot, with ulcers, and can neither walk any distance nor stand at a bench, amputation will be called for. A good below-knee stump and a well-fitting artificial limb is not a crippling disability. It permits of good function, of walking any reasonable distance, and of standing at work. These men do not lose working days. There are many patients with partial recovery following suture who would be better off with an amputation, and this is even more to be advised when there is the complication of a vascular lesion and some added ischaemia.

It is of interest that some patients with no neurological recovery have good function, and it is the estimate of the functional state on which the decision must be made.

In assessing the results of suture from the neurological standpoint, the sciatic is best considered under its two divisions, the medial and the lateral popliteal. The M R C analysis is made in this way, and the results are as follows. The figures are taken from the five centres with a minimum follow-up of twelve months for the motor and of two years from the time of suture for the sensory.

**Medial Popliteal**—Of 109 sutures, 49 per cent showed recovery of *voluntary* power in the calf, and 51 per cent some *pain sensibility* in the foot (Figs 497, 498), but motor and sensory recovery do not

M R C follow-up of 190 patients, 12.7 per cent recovered action in the dorsiflexors against gravity, 87 per cent failed (Fig 500). In our centre the figures with a longer follow-up are slightly more encouraging, as 31 per cent recovered power of dorsiflexors (Fig 501).

It is fortunate that the functional disability is slight. A toe-raising spring will replace the action of the paralysed dorsiflexors of the ankle (Fig 502). The attachment of the spring to the shoe should be on the outer side, as otherwise there is a tendency for the foot to assume the varus position (Fig 503).

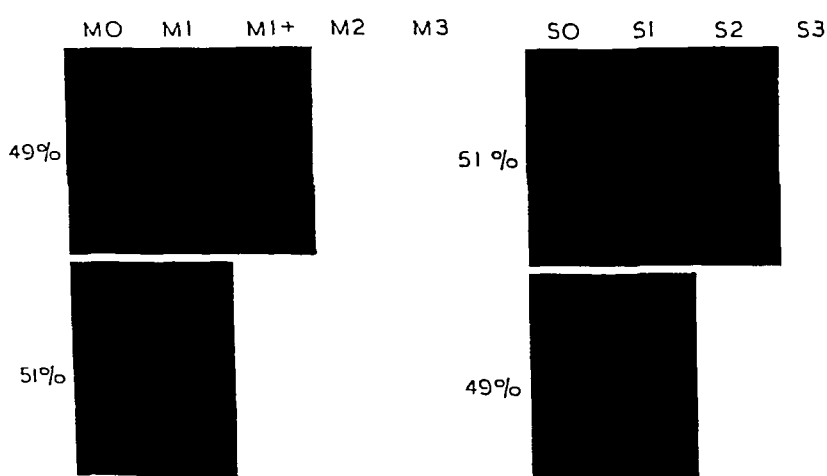


FIG 497—Motor recovery in 109 medial popliteals sutured over one year

ONE YEAR OR LONGER FOLLOW UP

MI+ - POWER AGAINST GRAVITY

FIG 498—Sensory recovery—109 medial popliteals sutured over two years

necessarily synchronize. In our series of 63 sutures, 22 per cent reached adequate recovery, both motor and sensory (Fig 499).

**Lateral Popliteal**—Here the results are poor, and the percentage of complete failures is high. In the

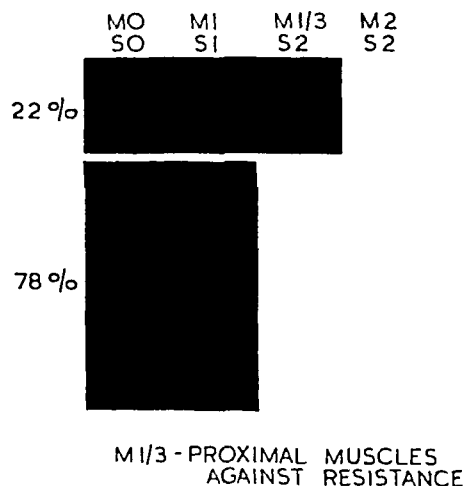


FIG 499—Recovery in 63 medial popliteals sutured over one year

MI/3 - PROXIMAL MUSCLES AGAINST RESISTANCE

A night splint should be given if there is voluntary power in the calf, as otherwise fixed flexion deformity of the ankle—equinus—will follow, from unopposed action of the calf muscles.

When both elements of the sciatic are divided it is surprising to find that the results of suture are as good as, and indeed in our series of 33 cases are rather better than, with suture of one element alone.

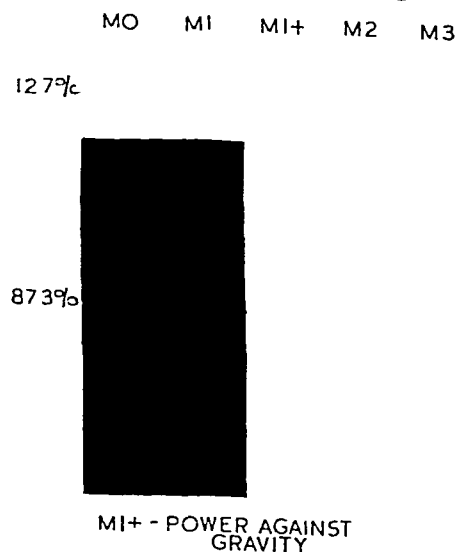


FIG 500—Motor recovery in 190 lateral popliteals sutured over one year

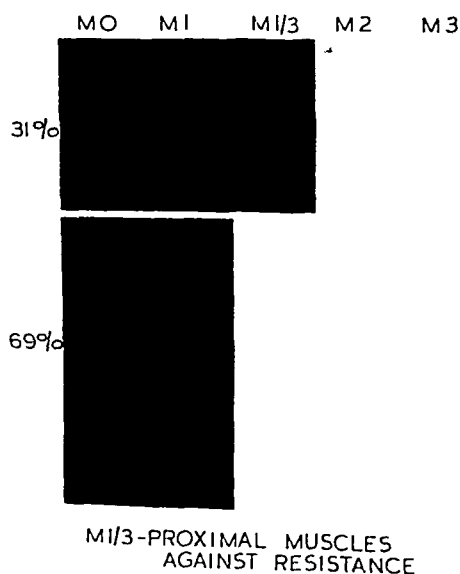


FIG 501—Motor recovery in 104 lateral popliteals sutured over one year

MI/3 - PROXIMAL MUSCLES AGAINST RESISTANCE

(Fig 504) This means adequate motor recovery in both divisions, with sensory recovery in the medial popliteal element Professor Seddon tells me the Oxford figures show a similar finding

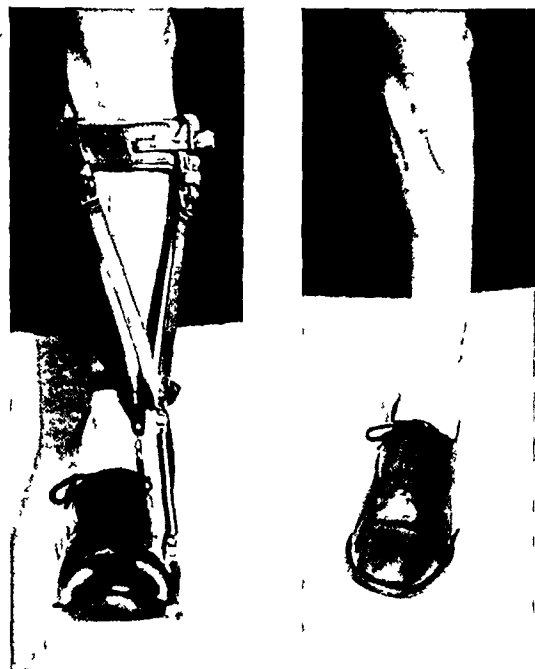


Fig 502

Fig 503

FIG 502—Toe elevating spring correctly adjusted to the outer side of the foot, with lateral iron

FIG 503—Illustrates tendency of the foot to fall into varus in the absence of the spring on the outer side of the foot

### RESULTS OF BULB SUTURE

If the gap found at operation is too wide to be overcome by the usual technique of free exposure, posturization of the limb, and so forth, bulb suture—the two-stage operation—should be considered

The numbers are small—we have only 3 or 4 cases, and a similar number have been done at the Oxford Centre, but for what it is worth it may be said that in both centres the results following this two-stage operation are just about up to the average of an ordinary suture. This is somewhat surprising in the light of our experience of traction lesions and nerve stretching generally, but is encouraging. The difficulty arises in that the surgeon may not realize that he is up against a gap too great to permit of suture until he has paired back the bulbs. It is not always possible to be sure how much one will have to sacrifice in either the distal or the proximal stump before the nerve face is good enough for suture. In doubtful cases it would seem wise to do a bulb suture, unless one can be fairly sure that the cut faces can be approximated end to end.

### NERVE-GRAFTING—THE PRESENT POSITION

In reviewing the lessons of the 1914–18 war, it was stated that nerve-grafting was condemned, excepting as a last resort, and that the results of this

operation were generally failure, and that those claimed as successes seldom stood up to a critical examination

Heterogenous and homogenous grafts are still to be regarded as failures in our experience in this

MED	} MO	MI	M1/3	M2	M3	M4
LAT						
MED -	SO	S1	S2	S2	S3	S4

33%

66%

M1/3 - PROXIMAL MUSCLES  
AGAINST RESISTANCE

FIG 504—Recovery in 33 sciatics sutured over one year

country. The Russians have used homogenous grafts, according to the scanty literature which has found its way over here, and claim good results. The American surgeons at the Walter Reed in Washington in 1944 were carrying out homogenous grafting operations. Our results in this field are all failures and several small series have been reported (Barnes, Bacsich, and Wyburn, 1945).

The position with regard to autogenous grafting is more hopeful, and especially in the case of purely sensory nerves such as the digitals.

Stirling Bunnell and his followers have also obtained satisfactory recovery by autogenous grafting of the digitals.

It is worth while, then, to explore still further the possibilities of the autogenous graft, and this is being done (Table VII). For example, a hand with complete cutaneous anaesthesia of the median area is for practical purposes a useless hand. If there is irreparable damage of the median and ulnar, the ulnar may well be sacrificed and a length of ulnar used to bridge the median gap. The cross-section of the graft and the host should be roughly equal. A single strand of the radial taken from the forearm would be useless for bridging a gap in the median in the arm, therefore, two or three lengths—the so-called cable graft—is used. Fibrinogen plasma (glue) is the ideal material in joining these small nerves, as they can be co-apted without tension.

One final word concerning grafts. Whilst a difficult suture is a laborious and time-consuming operation, a grafting operation by comparison is simple. The surgeon must make very sure that he is in fact driven to use an autogenous graft, and that in spite of all his persistence and ingenuity

he is compelled to abandon direct end-to-end suture, for all our present experience leads us to expect that the best recoveries follow suture

Topographical confusion in regeneration will be greater if we are called upon to trim back the nerve-ends for any distance before we find the faces of the

Table VII—RESULTS OF AUTOGENOUS GRAFTING

(Represents the experience of the Oxford Centre up to date, as reported at the XLIX Congres français de Chirurgie, Paris, October, 1946 This is reproduced by the courtesy of Professor Seddon)

TYPE OF GRAFT	NERVE	CURE	PARTIAL CURE	FAILURE	OPERATION RECENT	TOTAL
Cutaneous nerve	Digital	7	2	6	1	16
Cable graft	Brachial plexus	—	1	2	—	3
	Median	4	—	1	1	6
	Various	2	1	1	—	4
Thick grafts	Median	8	—	2	3	13
	Sciatic	—	1	—	4	5
	Various	1	—	3	—	4
Partial Lesions— Cutaneous nerve	Brachial plexus	1	—	1	—	2
	Median	—	—	—	2	3
	Ulnar	1	—	—	2	3
		24	5	16	13	58

### SOME REASONS FOR FAILURE

Apart altogether from gross lesions with a large area of destruction, when end-to-end suture may be impossible, a detailed study of the histology of the suture line will convince us at once that we are expecting the impossible if we look for anything approaching 100 per cent neurological recovery (Figs 505-507)

stumps sufficiently good to suture. The internal anatomy of the nerve-trunks has been worked out in considerable detail, if with varying results following the pioneer work of Stoffel, of Heidelberg (1912), down to the recent work of Sydney Sunderland in *Brain* (1945), and although the surgeon will do all he can to avoid axial rotation or torsion of either proximal or distal end, it is obvious that co-aptation cannot be accurate. A sensory or motor fibre will grow down an empty Schwann sheath, but if a motor

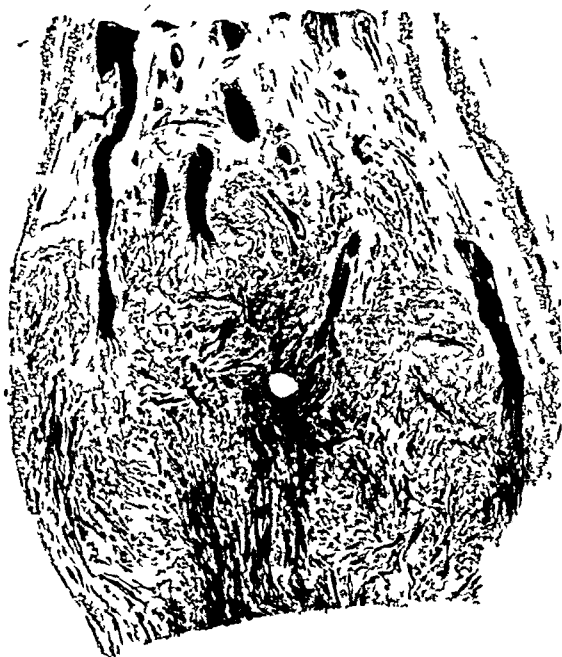


FIG 505—Shows a neuroma junction with excellent approximation. It shows the best that can happen at a junction (according to Greenfield) and illustrates the constant ramification and intercrossing of nerve fibres which run transversely and obliquely rather than longitudinally, passing from the upper to the lower end



FIG 506—Illustrates an unhealthy neuroma, with beading of many of the axons, which are sparse, and dense fibrous tissue in excess. The section is taken from a neuroma of the external popliteal, a lesion in continuity, which was rightly resected and sutured, and which made a good motor recovery two years after suture

fibre has gone astray, it will make no connexion with a sensory end-organ. Similarly a sensory fibre will make no connexion with a motor end-plate. Hence a mixed nerve like the ulnar should be far more



FIG. 507.—The proximal end of a divided median gives a good idea of the multiplication of axons at the point of outgrowth. The illustration shows many groups of nerve fibres, three and four distinct myelin sheaths within a common sheath. This patient was making a normal recovery when last seen.

likely to fail to recover neurologically than a pure sensory nerve such as a digital, and this is what we find in practice.

Again, at times we are of necessity forced to suture when the freshly cut ends do not look too

that axons are regenerating, that there is activity. The macroscopical appearance of the trimmed distal end at the time of suture may be deceptive. The nerve may feel normal and the sheath may strip easily if there is no general interstitial fibrosis and the collagen is in the nerve-bundles. The fibrosis in the bundles may be central or peripheral. This collagen formation fills the Schwann tubes and forms as far as is known a permanent barrier to the down growth of the axon (Figs 508-510).

These sections from our centre which Professor Greenfield has kindly prepared and reported on illustrate some of the difficulties the axon encounters and in part explains the poor recovery of neurological recovery.

It is commonly held that the surgery of peripheral nerves assumes importance only in war, and plays a very small part in the surgery of civil practice. With the large number of accidents occurring both in industry and on the road with modern transport conditions, the problem is one which is taking on considerable proportions (Table VIII).

In the Birmingham Accident Hospital William Gissane, the Clinical Director, informs me that in one year some 40 digital nerves are repaired, roughly 10 medians or ulnars about the wrist, 1 or 2 about the elbow, and similarly 1 or 2 lateral popliteals divided just below the knee. It is the practice at that hospital to suture the nerves when the wound is dealt with primarily, and the results are reported to be good—for example, a patient recently was returned to a precision job in a factory after suture of six digital nerves in the right hand, following a cut in the distal part of the palm.

Thanks to the work of Stirling Bunnell and his followers, the importance of the digital nerves is now realized, and their repair has a definite place in the reconstructive surgery of the hand.

Training both in the diagnosis and in the treatment of peripheral nerve injuries will need to be stressed, especially for those who intend to practise accident surgery. It is within the experience of many surgeons to have seen unfortunate results

Table VIII.—CAUSAL FACTORS  
(Jan 1, 1941, to Dec 31, 1946)

	G S W	ACCIDENTAL DAMAGE— MOTOR CYCLE, ETC	FRACTURE OR DISLOCATION	LACERATION	TOTAL
Brachial plexus	51	55	16	1	123
Median	375	10	11	55	451
Ulnar	538	33	34	59	664
Radial	272	20	28	1	321
Dorsal interosseous	77	1	4	3	85
Axillary	10	9	6	—	25
Musculocutaneous	19	—	2	—	21
Internal popliteal	357	10	19	3	389
External popliteal	462	20	30	8	520
Posterior tibial	35	1	1	—	37
Total	2196	159	151	130	2636

good, because we realize that further trimming will leave a gap preventing approximation. We have microphotographs of the face of the proximal and distal stump filed with the notes, and it is rather the distal than the proximal face which is of importance. The fact that a proximal end-bulb is formed means

following the repair of cuts about the wrist, and to have met with a divided median or ulnar joined to a tendon, the true state of affairs being unrecognized. There is nothing especially difficult in diagnosis, but the pitfalls and abnormalities met with must be appreciated.

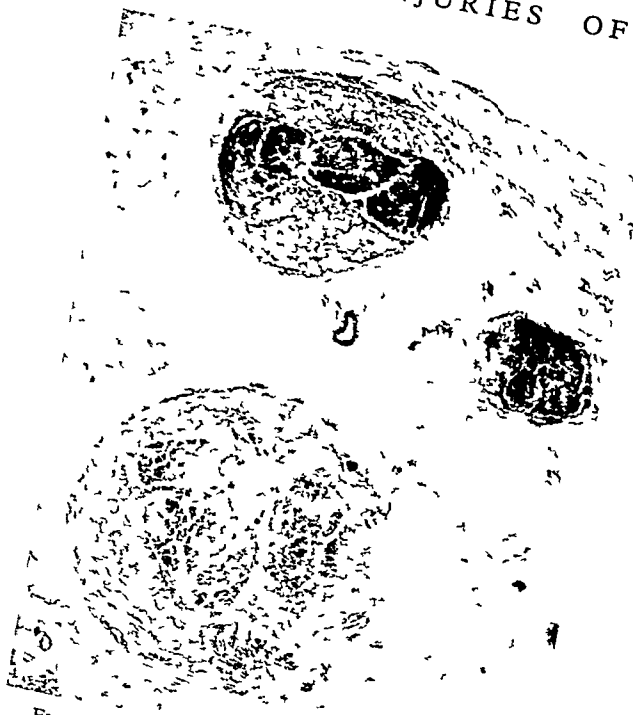


FIG 508 —Shows crescents of fibrosis in many bundles and is from the distal face of a sciatic sutured nearly two years ago and which has shown no sign of recovery



FIG 509 —From the distal face of an ulnar showing central and paracentral fibrosis and some normal fibres. Sutured just over three years ago and shows recovery well up to average



FIG 510 —From a sciatic Shows again central fibrosis or collagenization in the bundle. This sciatic was sutured in 1943, two years and three months after wounding as he was a P.O.W. He made no recovery and the leg was amputated

As a complication of fractures, peripheral nerve damage is not infrequently seen, but complete division is rare

There are many points which cannot be discussed in the time at our disposal—the whole question of pain, the pain of over-reaction, which in the majority of patients gradually passes off, although I well remember an officer in the 1914 war in whom recovery reached this stage and remained stationary for fifteen months. His was the pain of over-reaction, and finally, I amputated because he was prevented from walking or even standing with weight on that foot

Causalgia, the distressing condition described originally by Paget, but generally ascribed to Weir Mitchell, characterized by burning pain, intense, persistent, and subject to exacerbations, is fortunately rare, and in its severe form has only occurred some four times in our series. It must be sharply differentiated from the pain of over-reaction

The difficult problem of the treatment of the lesion in continuity and the partial lesion, when the surgeon is called upon to exercise his judgement in deciding whether to resect and suture or to leave, must be left for discussion at a later date, and so must the complication of aneurysm and the need for early operation before the nerve is ruined and incorporated as part of the aneurysmal sac

These and many allied parts of the whole story of injuries to peripheral nerves are a fascinating study and will give interest to our subject for some time to come

I wish to express my grateful thanks to a number of my colleagues for their valuable co-operation in the work of the Pyrford and Botley's Park Nerve Unit, and in particular to Dr B M Unkauf, who attended to the after-care of the patients, was

responsible for the notes, and prepared the illustrations and histograms. I would also like to thank Dr J M Greenfield, who carried out the pathological work in his laboratory at Queens Square, and advised me on the preparation of this section of the paper



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PENICILLIN THERAPY IN LATE INFECTED COMPOUND FRACTURES FROM BURMA

LIEUT-COLONEL H R H HARLEY, I M S, I A M C  
MAJOR J H BOWIE, I M S, I A M C  
AND CAPTAIN M D BORCAR, I M S, I A M C

THESE observations are the result of the study of wounds in 75 British troops with late infected compound fractures admitted to the War Wounds Research Centre in Secunderabad, four months on an average after being wounded in Burma

ON ADMISSION

**General Condition**—Before being wounded, some of the patients had been on 'K' or similar rations for as long as three months and in the blood of 55.9 per cent malaria parasites had been demonstrated, for months many had suffered from intermittent attacks of diarrhoea and dysentery

Many of those admitted during the hot weather were suffering from effects of heat sustained during their long journey by road, sea, and rail

Seven cases were admitted with all the signs and symptoms of a severe vitamin-B complex deficiency. Lieut-Colonel J A Manifold, R A M C, had observed that many of the wounded evacuated from Burma were suffering from a macrocytic anaemia. Among this series of 75, 48 were anæmic (28 of these were moderate or severe) and 38 were macrocytic in type. There was no achlorhydria and the Van den Bergh test was negative. Since manifest avitaminosis was present in one-tenth of the cases, it may be assumed that the macrocytic anaemia, present in more than half the cases, was due to dietetic deficiencies in the forward areas in Burma

**The Fracture**—All the cases had open wounds over the site of the fracture. Where bony union had not occurred before admission, the patient was often seriously ill

Table I—DETAILS OF FRACTURES

FRACTURE	NO	UNITED	UNUNITED	AMPUTATED
Humerus	2	2	—	—
Femur	36	10	23	3
Tibia and fibula	10	5	5	—
Tibia	4	4	—	—
Fibula	3	3	—	—
Ankle	1	—	1	—
Talus and 1st meta tarsal bone	1	1	—	—
Calcaneus	2	1	1	—
Scapula	1	1	—	—
Humerus	10	6	4	—
Ulna	1	1	—	—
Radius	1	1	—	—
3rd metacarpal	1	1	—	—
Totals	73	35	35	3

In the 33 fractures of the femur, the fracture site was as follows —

Upper third	14
Junction of upper and middle thirds	1
Middle third	6
Junction of middle and lower thirds	2
Lower third	10
Total	33

Of the 73 fractures, 3 of the femoral fractures had been amputated in the forward areas, leaving a total of 70. Of these, 68 cases were subsequently evacuated or discharged and only these will be considered in assessing results. In these cases, a total of 128 wounds were treated, 84 by suture and 44 without suture. Of the 84 sutured wounds, 68 communicated with an infected fracture, either united or ununited, and the remaining 16 wounds did not.

**The Wound Flora**—Plaster casts often interrupted bacteriological study of the wounds.

In view of the age of the wounds, anaerobic cultures were only set up where the possibility of such infection was suspected after examination of the direct smear or from the clinical aspect, i.e., in cases where the absence of pyogenic cocci in the wound discharges and in cultures of bone incriminated a Gram-negative organism as the pathogen.

Pyogenic staphylococci were identified by the production of haemolysins for human blood, pigmentation, mannitol fermentation, and the coagulase test.

Organisms of the proteus group were present in more than half the specimens examined. The majority of species encountered tended to swarm over the surface of culture media and render the identification of other microbes difficult. The incorporation of chloral hydrate (Lode and Howard, 1932) in the culture media proved invaluable in inhibiting this tendency. In a final concentration of 1-500, the drug did not inhibit the growth of any other organism found in the wounds.

Table II—THE INCIDENCE, ON ADMISSION, OF VARIOUS ORGANISMS IN THE WOUNDS OF 65 CASES

MICRO ORGANISM	NUMBER OF CASES IN WHICH THE ORGANISM APPEARED	PERCENTAGE
<i>Str. pyogenes</i>	18	27.7
<i>Staph. aureus</i>	25	38.5
<i>Ps. pyocyanea</i>	13	20.0
Proteus group	35	53.8
<i>Coli aerogenes</i> group	7	10.7
Diphtheroid group	23	35.4
<i>Str. viridans</i> group	6	9.2
<i>Staph. albus</i>	5	7.7
Other organisms (non pathogenic)	3	4.6

Table II was compiled from the results of examinations performed for each patient on two consecutive days at the time of admission or, where the wound was hidden by a plaster cast, when the wound was first exposed in the Centre.

On an average six subsequent examinations were carried out in this group of fracture wounds, at intervals of ten days. Of the 65 cases, 43 (66.1 per cent) acquired superadded infection while in hospital in spite of all feasible aseptic precautions.

Before dressings were commenced in the ward a quiet hour was observed during which no unauthorized person was allowed into the ward, bed-making and floor-sweeping were forbidden, and the electric fans were switched off. During 'dressing hours' all patients and staff were masked and the 'no touch' technique was used by specially trained sisters in

charge of dressings. All movement in the ward was reduced to a minimum, and special emphasis was laid on gentle manipulation of bedclothes.

A comparison between the incidence of the various organisms as they appeared in wounds on admission and as they appeared in hospital infections, reveals that, with exceptions, the two were directly proportional. This relationship indicates that the source of hospital infections was other wounds in the Centre. The exceptions suggest that these infections were generally airborne, this is hardly avoidable in a Base hospital during the hot weather when fans are a necessity.

## OBSERVATIONS ON PRELIMINARY INVESTIGATIONS AT THE BASE

**Result of Penicillin Therapy in Forward Areas on Wound Flora**—Wounds may be classified as Gram-positive or Gram-negative according to the presence or absence of pyogenic cocci in the discharge.

Considering, month by month for a year, the admission of patients to whom penicillin had not been administered in Forward Areas, the number of Gram-positive wounds was never less than the number of Gram-negative wounds. The relationship for the year was 11:10.

Among those to whom penicillin had been administered, the number of Gram-positive wounds fell progressively quarter by quarter—demonstrating a progressive improvement in Forward operative technique and associated penicillin administration. During the last three months of the Burma Campaign the proportion of Gram-positive to Gram-negative wounds had fallen from 11:1 to 1:9.

Inadequate penicillin administration in Forward Areas, whilst reducing the rate of *Str. pyogenes* infections by one-third at the time of admission to the Centre, also raised the rate of resistant pyogenic staphylococci from 0 to 30 per cent.

**Penicillin-resistant Pyogenic Staphylococci**—Having isolated and identified the staphylococcus in pure culture, a rough indication of its sensitivity was obtained by plate tests, thereafter a more exact sensitivity value was determined by culture in appropriate serial dilutions of penicillin (equivalent of P.B.S.) in broth. A control series inoculated with a standard test organism (N.C.T.C. 6571A) was always set up.

Penicillin-resistant pyogenic staphylococci may occur in wounds as a natural phenomenon, 16 strains were examined from the wounds of patients who had never had penicillin and all proved sensitive to 0.04 units per ml. The resistance of normally sensitive strains may be enhanced by inadequate penicillin therapy, 14 were examined and 4 (29 per cent) were resistant to 0.04 units per ml. Resistant strains may gain access to wounds as cross-infections, 13 strains in hospital infections were examined and 4 proved resistant (31 per cent).

If *Staph. aureus* is present, its sensitivity should be determined before starting treatment and the dosage of penicillin calculated accordingly. Strains whose resistance are up to 16-32 times greater than the Oxford staphylococcus were satisfactorily controlled by increasing the dosage accordingly. Very resistant strains are outside effective control and contra-indicate the use of penicillin, unless or until

the resistance falls to within reasonable limits. In treating strains whose resistance is within reach of penicillin therapy, it is most important that an adequate dosage be administered from the start, lest their resistance be increased beyond the level of penicillin which can be maintained continuously in the body.

In several cases it was noted that a rapid and striking increase in the resistance occurred as the result of inadequate penicillin therapy. In one case the resistance of the infecting organism on admission was between 16 and 32 times as great as that of the test organism. Six days later it had become 780 to 1560 times more resistant. During this period the patient was receiving 20,000 units of penicillin every three hours—a grossly inadequate dose in this case.

It was our experience that intramuscular injections of 20,000 units of penicillin every three hours, combined with suitable surgery, controlled infections due to strains of *Staph aureus* the sensitivity of which is equal to that of the standard Oxford staphylococcus, but that they will not control infection due to more resistant organisms.

A united compound fracture of the upper end of the humerus, with a sinus leading to bone, proved to be infected with *Staph aureus* twice as resistant as the test organism. Penicillin therapy, 30,000 units every three hours, was started, 48 hours later the sinus was excised, radical removal of bone performed, and the wound totally sutured under no tension and without drainage. After operation pyrexia occurred, a superficial sinus appeared in the wound, from which the staphylococcus was recovered, and the wound showed signs of inflammation. The staphylococcus was now between 2 and 4 times as resistant as the test organism. The dosage was increased to 40,000 units. The temperature immediately fell to normal, inflammation subsided, and the sinus closed within four days.

A second patient had an infected compound fracture of the upper end of the femur. His general condition was poor and deteriorating rapidly, he had been receiving 20,000 units of penicillin every three hours for 28 days. When we saw the patient he was gravely ill with high swinging temperature and rapid pulse. A *Staph aureus* 16 to 32 times more resistant than the test organism was recovered from the wound. The dosage of penicillin was increased to 200,000 units every two hours and maintained at that level for 19 days. There was an immediate response on the temperature and pulse charts and a striking improvement in the general condition. Four days later the grossly diseased head of the femur was removed and the infected hip-joint drained, the general condition caused no anxiety either during or after the operation. Subsequent progress was satisfactory. Massive penicillin therapy probably saved his life. He received the enormous dose of 23.2 mega units.

The dosage of penicillin necessary to control infection due to *Staph aureus* depends upon the sensitivity of the organism. In a case of purely Gram-positive infection where the clinical response to penicillin is disappointing, inadequate therapy should be assumed, and the sensitivity determined as rapidly as possible.

The exact relationship between resistance and dosage necessary is at present unknown. In treating infections due to resistant strains of *Staph aureus*, continuous administration of penicillin would provide the most accurate method of giving the exact dose required. Were a really satisfactory method of continuous administration available this would be the ideal method of treating cases of this type. It is hoped that the electric apparatus for continuous injection devised at Secunderabad will provide one possible answer to this problem. This apparatus will form the subject of a separate report.

#### Pathogenicity of Gram-negative Organisms

—With power to control Gram-positive pyogenic cocci by the exhibition of penicillin, we were impressed by the virulence of some Gram-negative infections in bone and by their ubiquity in wounds in the East.

It has been shown that proteus was present in over half the wounds, *Ps pyocyanea* in a fifth, and *Bact coli* in a tenth. These Gram-negative organisms were the cause of nearly all the failures of wound closure, they were much the most common cause of chronic low-grade infection in bone, leading to persistent sinuses, and they were the major cause of virulent spreading infection threatening life or limb. This is well illustrated by the fact that in the 4 cases of this series for which amputation was necessary in the Centre for fulminating infection the causal organisms in 3 were proteus and *Ps pyocyanea*, no pyogenic cocci or anaerobes were found on repeated examination. In the fourth case a mixed infection was present with *Staph aureus* and *Str haemolyticus* on the one hand, and proteus, *Ps pyocyanea*, and *Bact coli* on the other. No amputation was performed in the absence of Gram-negative organisms. The combination of general treatment, penicillin therapy, and surgery did not influence the course of the disease in any of these four cases.

Now that *Str pyogenes* and most strains of *Staph aureus* can be controlled by penicillin, Gram-negative infection must be regarded as a major hazard in this theatre so far as compound fractures are concerned.

**Fallacies in Radiological Interpretation**—In this series of late infected compound fractures three difficulties were encountered in the interpretation of radiographs—

1. **Infection**—The heavily comminuted fractures resulting from war injuries lead to gross disruption of bony architecture in the region of the fracture. When to the direct effects of the injury are added the radiological changes produced by reparative processes, a complicated picture results. Infection occurring on such a background does not give rise to the radiological features usually associated with osteomyelitis.

Less and less reliance was placed on X rays in endeavouring to assess the extent of infection present in common comminuted fractures before union had occurred. Extensive spreading intramedullary infection was found at operation on several occasions when the radiographs gave no evidence of its presence. In one such case of compound fracture of the femur infection was demonstrated in the marrow cavity for 8 in. above the site of fracture. When

union had occurred the radiographs provided reliable evidence of the extent of infection

2 *Sequestration*—In the more severely comminuted fractures it is sometimes impossible to differentiate portions of living cortex from sequestra. These portions of cortex may remain denser than the surrounding bone. They can be recognized as cortical fragments by virtue of their shape, but they cannot be positively identified as sequestra solely on their density. Several operations were performed for the removal of such fragments which had been regarded as sequestra on radiological evidence, but were found to be living fragments of cortex firmly attached to soft tissues from which they received an adequate blood-supply.

3 *Bony Union*—In extensively comminuted compound fractures, clinical union may be firm, although radiographs provide no evidence of union. We were surprised on more than one occasion to find that a fracture was clinically firm when examined in the operating theatre although the X-ray picture had led one to suppose that it would be freely movable.

### TREATMENT AT THE BASE

Treatment was carried out along four main lines—general, chemotherapeutic, surgical, and orthopaedic.

**General Treatment**—This consisted mainly in dietetic replacement therapy.

For effects of heat on admission the patients required sedatives, rest in cool, dim, quiet wards, and 3–4 litres of cold fluids a day.

Diets particularly rich in proteins were devised to include liver, vitamins, and iron. Repeated blood transfusions, sometimes over a period of many weeks, were necessary in the more seriously ill patients. Fresh blood was used in preference to stored blood. It was remarkable how rapidly the red-cell count and haemoglobin fell to the pre-transfusion level in the presence of severe toxæmia. In this type of case, treatment was controlled by serial haemograms as long as severe toxæmia persisted.

On admission, the plasma proteins were frequently low, plasma, whole blood, and hydrolysate were not spared in these cases.

On the grounds that every degree Fahrenheit rise in body temperature entails a 10 per cent increase in the basal metabolic rate, the toxic cases were pressed to consume high-calorie diets.

**Chemotherapeutic Treatment**—The main object of this investigation was to determine the efficacy of penicillin administration in the treatment of late, infected compound fracture cases from Burma at bases in India.

Penicillin was administered to every case, irrespective of the bacteriological findings and no other chemotherapeutic agent was employed.

For the first two months 15,000 units were injected every three hours, subsequently this was increased to 20,000 units. Eventually the dose was correlated as far as possible with the resistance of the particular staphylococcus.

With regard to pain, we found nothing to choose between sterile glass-distilled water and sterile buffered saline of pH 6.8 which we use as the routine vehicle. A reduction in the volume of the injection

from 3 to 2 ml, however, definitely reduced the discomfort produced by the injection. In the same way, using continuous penicillin therapy, we found that reduction in discomfort was proportionate to reduction in volume through the range 100 ml (Eudrip), 20 ml, 10 ml, and 2 ml (Secunderabad apparatus) in 24 hours.

Our routine was to begin penicillin therapy 48 hours before operation, with the object of (a) rendering the blood and tissues at the site of operation bactericidal, and (b) eliminating infection in blood-bearing tissues. The injections were continued after the operation for a period which depended on the clinical response.

Local instillation via narrow-bore rubber tubes was employed in 16 cases. In 8 of these there was strong evidence that penicillin-insensitive secondary infection gained entry via the tubes, this method was therefore abandoned as a routine. Thereafter penicillin tubes were only inserted where a dead space was unavoidably left at the end of the operation.

**Surgical Treatment**—Where there was absence of union of the fracture on admission the general condition of the patient was always more grave and the treatment more difficult. A success rate of 57 per cent for united fractures, as against 45 per cent for ununited fractures, reflects the difficulties encountered.

Operative procedures aimed at excision of the wound, radical removal of all bone which was dead or had a diminished blood-supply, obliteration of dead space (if necessary, by saucerization or turning in a muscle flap), and total suture of the wound without drainage.

This procedure was not always possible. Radical removal of bone aimed at leaving behind only bone which looked healthy and which bled, irrespective of whether microscopical infection was or was not present. This was usually possible when the fracture was united, often impossible when it was ununited (a) because an irreparable gap might result and (b) because it is difficult to assess the blood-supply of comminuted fragments. In many such cases conservative removal of bone, i.e., sequestrectomy, had to be performed.

Obliteration of dead space in bone proved most difficult in the upper quarter of the tibia, a situation where muscle and skin are apt to be deficient. On three occasions a large cavity in the upper end of the tibia was filled with iliac chips and the overlying skin then sutured, on each occasion the wound broke down and the iliac chips were extruded as the result of Gram-negative infection. In all 3 cases the cavity was large and the skin was stitched under considerable tension. In a case of non-union of the ulna in which there was a  $\frac{3}{4}$ -in gap and a sinus down to the site of fracture from which *Staph aureus* was cultured, primary union followed excision of the wound and the insertion of iliac chip grafts under the protection of a penicillin 'umbrella'. The grafts persisted and fused into a single mass which united with the lower fragment.

Total suture was sometimes impossible owing to loss of skin.

In 3 such cases Lieut-Col Peet, R.A.M.C., closed the gap by sliding across a flap of skin and applying Thiersch grafts to the donor area.

This procedure was only found necessary in fractures of the upper third of the tibia and in all three it was eminently satisfactory. Plastic closure should always be preferred to the slow and painful process of healing by secondary intention.

In all cases where dead space could not be obliterated, drainage was provided by partial suture of the wound or by counter drainage.

More and more care was taken in the technique of skin closure, careful suturing repays the time and trouble taken. Tension was found to be an important cause of wound breakdown.

The results of radical as compared with conservative excision of bone were interesting. For united fractures the radical operation gave the better results, 50 per cent of successes as against 38.5 per cent for the conservative operation. In the case of ununited fractures the success rate was identical for both operations—namely, 40 per cent. The probable explanation for this discrepancy is that radical removal of diseased bone was technically possible in the case of united fractures, but not in those that were ununited. It is probably not worth attempting to perform the radical operation before union has occurred.

It was not possible to draw any conclusions as to the relative merits of total suture without drainage, total suture with counter-drainage, and partial suture because the numbers in the latter two groups were too small.

**Results**—Of all the factors influencing the success of operative procedures designed to close the wound under cover of penicillin therapy, the most important was the bacteriology of the wound.

In this series of late infected compound fractures, it was found that (a) when only pyogenic cocci or 'miscellaneous' organisms were present the results were uniformly good, whether the fracture was united or not, and (b) when Gram-negative, penicillin-insensitive bacteria were present the results were poor.

All factors other than the bacteriology were constant, every case had penicillin therapy and all the operations were performed by the same surgeons, using a standardized technique. The results obtained are illustrated in Table III, which represents the position with regard to the bacteriological group at the time of operation. By success both here and hereafter is meant primary union of the wound or complete healing of the wound except for small areas of epithelial defect on the suture line or at the sites of sutures. All other results are classified as failures.

Table III indicates that in 15 cases in which there were no Gram-negative organisms (the sterile, Gram-positive, and miscellaneous groups) there was only 1 failure. The wound in this case broke down partially leaving a persistent sinus to bone and was examined thereafter on four occasions from the 6th to the 126th day after operation. *Proteus* was present on all four occasions, on the first alone and on the last three in association with diphtheroids. *Staph aureus* and *Str pyogenes* were not present on any of these four occasions, and anaerobic cultures were negative. This strongly suggests that the cause of failure was due to the presence of *Proteus* which probably gained entrance to the wound at or just before the time of operation, since it was present

at the first inspection of the wound after operation. There is thus no case in this series in which *Staph aureus* or *Str pyogenes* can be incriminated as the cause of failure.

On the other hand, in 62 cases in which Gram-negative organisms were present (the Gram-negative and mixed groups) there were 34 failures. These two sets of figures represent success rates of 93 per cent (> 100 per cent) and 45.2 per cent respectively.

Miscellaneous organisms, especially diphtheroids, were present in many of the Gram-positive, Gram-negative, and mixed groups of wounds. Thus

Table III—RESULTS OF TREATMENT

WOUND GROUP*	NUMBER OF CASES		
	SUCCESS	FAILURE	TOTAL
Sterile	2	—	2
Gram-positive	11	1	12
Gram negative	13	16	29
Mixed	15	18	33
Miscellaneous	1	—	1
Totals	42	35	77

\* Gram-positive Wounds. *Staph aureus* and *Str pyogenes*, either alone or together, or in association with any organism other than *Ps pyocyanea*, *proteus* or *coli-aerogenes* group.

Gram-negative Wounds. *Proteus* and *coli-aerogenes* groups and *Ps pyocyanea*, either alone, together, or in association with any organism other than *Str pyogenes* or *Staph aureus*.

Mixed Wounds. Any combination of organisms provided that at least two of the five important organisms are present—one from each of the Gram-positive and Gram-negative groups.

Miscellaneous Wounds. Any association of organisms other than the five important organisms mentioned above.

diphtheroids were present in 35.4 per cent of 65 wounds examined on admission. These organisms gave no evidence of pathogenicity.

Two inferences were drawn from these results—

1. Penicillin therapy will control infection, even in late compound fractures, due to *Staph aureus* or *Str pyogenes*, provided it is combined with adequate surgery.

2. *Proteus*, *Ps pyocyanea*, and *B coli* may be pathogenic when established in bone and were the main cause of wound breakdown and chronic suppuration in this series.

## DISCUSSION

**Indications for Penicillin Therapy in Late Infected Compound Fractures**—The investigation gave clear evidence that the sole criterion for giving, or withholding, penicillin was the result of bacteriological examination of the wound. It was established that where penicillin-sensitive pyogenic cocci alone were present, the results were excellent and the wound could be closed with confidence. When Gram-negative organisms were present, however, the results were poor, the wound broke down in over half the cases, and spreading infection, if present, was not controlled however good the surgery.

It may therefore be stated that when Gram-positive infection is present penicillin should be given, when Gram-negative infection is present penicillin should be withheld, and when miscellaneous infection is present penicillin therapy is unnecessary. When a mixed infection is present

penicillin should be administered to eliminate the Gram-positive element. The Gram-negative element will, however, remain, and good results must not be anticipated. Table III indicates that the results of wound closure associated with penicillin therapy were equally poor in the mixed and Gram-negative groups of cases.

Bacteriological examination of bone removed at operation in 34 cases revealed that in 32 (94 per cent) all the organisms isolated from bone had already been identified by examination of the wound discharges. This suggests that pus is a reasonably efficient guide as to the probable outcome of penicillin therapy in any particular case of late compound fracture. In the two remaining cases, *Staph aureus* was isolated from bone, but not from pus till after the operation. A sinus to bare bone was present in both cases. This suggests that a piece of diseased bone, removed at operation, should be examined as a check on the culture of pus.

**Secondary Hæmorrhage**—Secondary hæmorrhage occurred in only 2 cases, including one of the three amputated for pure Gram-negative infection. This patient had three secondary hæmorrhages after his amputation, the first of which was almost fatal. The second patient had a small secondary hæmorrhage from a branch of the superior gluteal artery. This followed a three-stage hindquarter amputation for spreading osteomyelitis of the pelvis originating in a compound fracture of the upper end of the femur. The infection in this case was mixed.

**Gas Gangrene**—No case of gas gangrene occurred.

**Mortality**—One patient in this series died, but his death was unrelated to his injuries. Just before he was due for discharge, he developed a fulminating type of infective hepatitis from which he died within a week. There was no death from sepsis in spite of the fact that only the most severe compound fractures were segregated in the War Wounds Research Centre.

### SUMMARY

1 Late compound fracture cases from Burma in addition to the conditions produced by their injuries, suffered from effects of heat, dietary deficiencies, macrocytic anæmia, malaria, diarrhoea, and dysentery.

2 In spite of all feasible aseptic precautions,

hospital infection occurred in 66 per cent of the wounds, these infections included a high rate of penicillin-resistant strains of *Staph aureus*. It was inferred that the source of infection was other wounds in the Centre, that the infection was airborne, and that electric fans were partially responsible.

3 It was observed that inadequate penicillin administration in Forward Areas reduced the number of Gram-positive wounds admitted at the Base, but produced a rise in penicillin resistance of the pyogenic staphylococci persisting in wounds.

4 Improvement in Forward penicillin administration was proved to be progressive, towards the end of the Burma Campaign it had become highly successful in the eradication of Gram-positive infection in compound fractures.

5 It is suggested that (a) The dose of penicillin should be more closely correlated with the resistance of the infecting organism, which should be determined by dilution tests, (b) That local penicillin should only be used where dead space is surgically unavoidable.

6 Operative procedures aimed at excision of the wound, removal of all bone without an adequate blood-supply, and closure of the wound without drainage. The usual technique used for the obliteration of dead space not amenable to saucerization was the turning in of a pedicled flap of muscle.

7 The results of treatment indicated that (a) Gram-positive infection in bone can be controlled by adequate penicillin administration associated with efficient operative procedures, even at a late stage in compound fractures, (b) Where penicillin is used effectively in compound fractures and eradicates Gram-positive infection, Gram-negative organisms are the main cause of (i) low-grade infection in bone leading to persistent sinuses, (ii) virulent spreading infection threatening life and limb.

We have pleasure in acknowledging the direction of Brigadier F. Harris, who created, encouraged, and equipped our team. We would like to thank Brigadier Grant Massie, who set and supervised our surgical problems.

We wish to express our gratitude to Colonel D. C. McEttles and his staff at 128 I.B.G.H. (B.T.), Secunderabad, for the innumerable advantages we gained through their co-operation.

## PARTIAL GASTRECTOMY FOR SIMPLE ULCER\*

### A REVIEW OF THE END-RESULTS OF 132 CASES, WITH A CRITICISM OF THE POLYA OPERATION

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" I am't gonna let my stomach dictate to me "

IMPRESSED by the frequency with which partial gastrectomy is being prescribed for simple peptic

\* Thesis presented for the degree of Ch. M. of the University of Birmingham

ulcer, a follow-up clinic was instituted at the Leicester Royal Infirmary to determine whether the results justified the operation, at the same time some undesirable side-effects of the Polya operation were seen, which led to criticisms of this type of anastomosis

Gastro-enterostomy is now almost entirely reserved for the long-standing organic pyloric stenosis, although there are a few isolated but very staunch supporters of this operation, notably Walton in this country, who advocate the use of this operation almost as the routine for duodenal ulceration. The majority of writers, however, are strongly in favour of gastric resection as the operation of choice, certainly for gastric ulcer, and almost always for duodenal ulcer.

The indications for operation in peptic ulceration have been gone into many times before, and it will suffice to say that most of the cases in this series were advised operation for three main reasons: (1) Lack of response to medical therapy—undoubtedly the war has increased this category of patient, (2) Repeated perforation or hæmatemesis, (3) A suspicion of malignancy—a large number of the older-age gastric-ulcer group lost parts of their stomach on this account.

For the purpose of this review, 129 patients were interviewed personally and 3 replied by letter. All operations were carried out prior to June, 1945, and at the time of interview no patient had been operated upon less than six months previously; patients seen after this date are not included in the figures, although the impressions from seeing them have been utilized.

The results of the follow-up are discussed under several headings, which consider points in regard both to technique and to the effect of partial gastrectomy on the patient, and some attempt has been made to decide which of the very many modifications of the operation give the best long-term results. The literature on partial gastrectomy is almost unanimous in saying that, at any rate so far, it is the best operation yet devised for the appropriate case, and one feels that it is time that attempts were made to correlate the types of operation, e.g., the width of the stoma, with more 'intimate' end-results, and so in this review I have discussed the results under three main and fairly separate headings, as follows: (1) Clinical and functional result, especially in connexion with the length of the loop and the width of the stoma, (2) The fractional test-meal, with particular reference to the operation of pyloric exclusion, (3) Anæmia.

**Mortality**—It has not been possible to work out the mortality for the whole series exactly, but it approximates to 9 per cent. The operation had not been extensively used at this hospital until within the last few years, and this has probably contributed to the high figure. The mortality-rate for one surgeon's personal series is now much less than 4 per cent, a figure which renders the operation one which can be safely advised to most patients.

**Type of Operation**—All the cases reviewed here are partial gastrectomies based on the modification of the Billroth II by Mikulicz and Kronlein and by Hofmeister and Reichel, and described in 1911 by Polya, by whose name it is now generally known. Many names have been applied to modifications of Polya's original method, but in this review the following terms will be used in describing the type of anastomosis—

Isoperistaltic—afferent loop to greater curvature  
Antiperistaltic—afferent loop to lesser curvature

Antecolic—long jejunal loop, passing anteriorly to colon

Retrocolic—short jejunal loop, posterior to transverse colon, passing through mesocolon

In this series the whole width of the stomach was anastomosed to jejunum in all but 2 cases, in these a Hofmeister type of valve was formed, one is an excellent, the other a good, result. Only 2 known antiperistaltic anastomoses were made, both with excellent results, 13 are of unknown type. In all, approximately two-thirds of the stomach was removed.

## CLINICAL IMPRESSION

The general impression gained from talking to these ex-patients is that the operation of partial gastrectomy is definitely worth while, and this, as shown later, is confirmed by the figures. Most of these patients express spontaneously their gratitude for the operation.

The average period of convalescence after operation has been three to four months, one man returned after one month and one, who was delayed by a subphrenic abscess, after eighteen months. Most of the workers have returned to their original employment and have not lost time from it since (excepting those in groups 3, 4, and 5 described later). A few have apparently been unable to work as hard as they did previously, but there has been no obvious cause for this, certainly there is no connexion between this inability and anæmia—a great majority of the anæmic patients were working full time.

A number of these patients have failed to increase their weight to their pre-sickness level. Most of them were sparse in build, some were actually worried about their failure to gain weight, and I did not see any patient who could be regarded as obese. Unfortunately these are only impressions, since no figures are available. This impression contrasts with Gordon-Taylor and Hudson (1928), who mention an average gain in weight of 2 st, but agrees with Ingelfinger (1944), who says that many patients find it difficult to gain weight, he quotes Santy and Mallet-Guy, who say that after three years only a few patients experienced difficulty in putting on weight. In about two-thirds of the cases in this review the operation had been performed less than three years previously. Despite their inability to put on much weight, no increased liability to ill health was noticed, on the whole, they appeared to have been extraordinarily well since operation.

**Appetite and Food**—Only 2 patients had abnormal appetites, one being more, and one less, hungry than normal. Patients had been advised to maintain an 'ulcer type' of diet for about six months after operation—most of them attempted to do so for a time, but, when seen, the greater majority were eating ordinary food.

On talking to patients about food, several interesting points emerge—their pre-operative experience with food and pain influences the post-operative life of quite a number of patients, hence one has notes of three patients who have been attempting to maintain the diet for over six years since operation—they had never been told to go on to normal food. Another patient who had had an ulcer for ten years said that he was "scared" to go off his diet.



It behoves the doctor to inform the patient that there will be no necessity to maintain a diet once the gastro-intestinal tract has settled down, in fact, from the point of view of anæmia and the functional end-result (*see later*) a good normal diet is to be strongly advised.

A large number of patients do not eat pickles or spices—most had been warned not to do so by their doctor, and none expressed a desire for them. A few (14 in number) mentioned specific articles of food which they found disagreed with them. In some cases they caused fullness, but in others nausea and vomiting of bile was brought on, sweet foods, as suggested by some writers as being the main stimulants of a flow of bile, were not especially incriminated by this group of patients. Many patients did say that fatty foods were "bad for their stomach", in most cases they caused nausea, and occasionally slight vomits of bitter fluid. This is perhaps associated with the well-known stimulating action of fats on the gall-bladder, with a consequent flooding of the stomach with bile, and is of interest in view of remarks by Ingelfinger, who quotes many references to suggest that some of the intestinal upsets after gastrectomy are secondary to abnormal pressure gradients between the stomach and the small bowel. Ingelfinger quotes from Ravdin, Royster, Reigel, and Rhoads (1943) as follows: "The feeding mixture should not contain too much fat, for even though the mixture is placed in the jejunum, gastric emptying is delayed. Failure to recognize this fact has greatly increased the time of convalescence of many patients."

### FUNCTIONAL RESULTS

The functional result, i.e., the present subjective state of the gastro-intestinal tract, has been subdivided as follows—

1 Excellent. There are no complaints of any sort. All these patients are at full work.

vomiting. All of this group say they have benefited from the operation. Some have lost time from work on account of their upset.

4 Not improved. Those with a severe gastric or intestinal upset, and who say they have not benefited from their operation.

5 Recurrent ulceration.

The results are grouped in *Table I*.

Several points emerge immediately—

1 95 per cent of the patients received benefit from the operation.

2 All 3 recurrences were originally duodenal ulcers.

3 Apart from recurrent ulceration, duodenal and gastric stomach remnants seem to behave equally well.

4 Time would appear not to have a very great effect in settling the intestinal upsets, despite its well-known soothing value during the early post-operative months, during which fairly severe upsets are not uncommon.

5 Perhaps of some significance, the 'not improved' exceed the recurrences in number.

### RECURRENCES

There were 3 patients clinically suspect of recurrence, although in none was the ulcer actually demonstrated.

*Case—C* M, male, aged 42, seen 4 years after a three-quarter resection for an anterior-wall duodenal ulcer. An isoperistaltic anastomosis. He complained of a mixture of symptoms, some of which were definitely due to anæmia, but he said that he was quite free from pain for 18 months after the operation. His symptoms were typically ulcer-like in their character and relation to food and alkalis. He was eating normal food with additional 2-hourly feeds.

F T M No free acid Low total acid Emptying time  $\frac{1}{2}$  hour.

Blood-count 83 per cent Hb 4,600,000 R B C

X-ray examination No evidence of ulcer, except slight tenderness. No gastric delay (Dr Lawson).

Table I—RESULTS

#### a General

		per cent
Excellent	53 (2 by letter)	40
Good	57 (1 by letter)	43.2
Improved	15	11.4
Not improved	4	3
Recurrences	3	2.3
Number of cases		132

#### b According to Site

Original Lesion	No of Cases	Excellent	Good	Improved	Not Improved	Recurrences
Duodenal	68	28 (41.2 per cent)	28 (41.2 per cent)	7 (10.3 per cent)	2 (2.9 per cent)	3 (4.4 per cent)
Gastric	59	22 (37.3 per cent)	27 (45.8 per cent)	8 (13.5 per cent)	2 (3.4 per cent)	0
Stomal	5	3	2			

#### c According to Length of Time since Operation

	No of Cases	Excellent	Good	Improved	Not Improved	Recurrences
Over 3 years	42	14 (33.3 per cent)	17 (40.5 per cent)	7 (16.7 per cent)	2 (4.7 per cent)	2 (4.7 per cent)
Under 3 years	90	39 (43.3 per cent)	40 (44.4 per cent)	8 (8.9 per cent)	2 (2.2 per cent)	1 (1.1 per cent)

2 Good. Patients with a mild upset in the way of flatulence or fullness after meals, which does not inconvenience them. Let it be said now that most of these patients only mentioned their symptoms on direct questioning—all are extremely pleased about the operation, and all are at full work.

3 Improved. Those who do complain of a definite 'upset' in the way of flatulence, fullness, or

*Case—H* W, male, aged 50, seen 1 year 8 months after an isoperistaltic antecolic resection for a duodenal ulcer. This man was well for six months after operation and then developed an atypical pain, rather like, but less severe than, his original ulcer pain. He is still maintaining a definite gastric diet.

F T M No free acid Low total acid Emptying time  $\frac{1}{2}$  hour.

Blood-count Normal.



X-ray examination Normal partial gastrectomy (Dr Lawson)

Gastroscopy Not successful

In this case the symptoms were to some extent obscured by jejunal 'dumping' pain

*Case*—C P, male, aged 50, seen 3 years after a high isoperistaltic antecolic resection for an indurated ulcer, with pyloric exclusion and excision of antral mucosa, the ulcer not being removed

F T M 20 c c of free acid Total acid 35 c c Emptying time  $2\frac{1}{2}$  hours

Blood-count Normal

X-ray examination No evidence of ulcer in stomach or stoma Small amount of jejunitis in the afferent loop, no overloading or obstruction (Dr Lawson)

Gastroscopy Patient did not attend

With regard to the temperament of the three patients—C M had many business worries, otherwise he seemed to be of fairly normal behaviour, H W was definitely introspective, C P was of normal behaviour

The following features are common to these three cases—

- 1 They were all males
- 2 The original lesion was a duodenal ulcer
- 3 The anastomosis was full width and antecolic
- 4 There was no X-ray or clinical evidence of afferent loop obstruction

These three cases support the common beliefs that duodenal ulcers are more likely to lead to recurrent ulceration, and that free acid is only a predisposing factor to ulceration

**The Long-loop Anastomosis**—All were of the long-loop antecolic type, and this is of interest in view of experimental evidence by Wangenstein (1945) and Lannin (1945), who show that in dogs recurrent ulceration is much more frequent in the long-loop type of anastomosis. They use a short-loop (retrocolic) anastomosis and have recurrence rates respectively of 1-400 and 0-300. Wangenstein says that not only does a short loop give more rapid neutralization of such acid as is formed by the stomach remnant, but that the lower down the jejunum one goes, the more prone is the bowel to ulceration. The knowledge that the intestinal juices are essential for the protection of the anastomotic line even after a gastrectomy led Gordon-Taylor and Hudson in 1928 to condemn the 'en-Y' anastomosis on account of the high incidence of recurrent ulceration. Entero-anastomosis between the loops has also been given up

Other figures of recurrent ulceration in relation to the two types of anastomosis are few and indefinite except in occasional incidences. Writers appear not to have segregated the long and short loops in relation to their recurrence rates. However, for what they are worth I quote the following results—

Sanders (1945), using mainly antecolic full-width anastomosis after a 60 per cent resection for duodenal ulceration, gives an 8 per cent recurrence rate

Keifer (1942) reported 11.4 per cent of gastro-jejunal ulcers in 173 extensive gastric resections, using mainly an antecolic long loop

Mangot, discussing the operation of pyloric exclusion, gives the low recurrence figure of 2 per cent in antecolic anastomoses. He actually prefers

the retrocolic variety, saying it is more physiological, but does not hesitate to use the anterior if difficulty arises

Strauss and others quote no recurrences in 221 cases of retrocolic anastomosis

Richter (1934) says "I believe the long loop with or without entero-anastomosis adds substantial danger of gastrojejunal ulcer"

Garnet Wright in 1934, discussing gastrojejunal ulceration, stresses that the anterior gastro-enterostomy is very much more prone to this complication than is the posterior variety. He was able to collect only a few cases of gastrectomy for duodenal ulcer, so few that the figures or recurrence rate are probably not reliable. They are antecolic 0 per cent retrocolic 2.59 per cent

The present series, antecolic 3.3 per cent recurrences (92 cases), retrocolic 0 per cent recurrences (34 cases)

The idea that the routine use where possible of the short jejunal loop would still further reduce the incidence of recurrent ulceration, would seem to be worth while investigating further in a larger series of cases. The difficulties of the opening in the transverse mesocolon, and obstruction of the loops, might well be lessened by the modification in technique described by Lahey and Marshall (1939) whereby the afferent jejunal limb is considerably mobilized by division of the ligament of Treitz. In the few cases in which the writer has personally performed this modification, the results have been gratifying, and so far as can be judged from these very recent cases the functional after-effect is satisfactory. One must admit, however, that anomalies of the ligament of Treitz are common and it is not always easy to use this modification of the posterior anastomosis

**Speed of Emptying**—One other feature common to all three recurrences in this series was a wide stoma. X-ray examination and F T M have confirmed that the stomach remnants empty readily and rapidly. Some American writers, e.g., Strauss and others and Sanders, emphasize that the rapid emptying of the stomach remnant gives greater protection against recurrent ulceration, mainly because more rapid neutralization of acid is effected. These three cases do not support that view, which does not seem to be widely held in Great Britain

## CONSIDERATION OF THE CASES SHOWING GASTRIC AND INTESTINAL UPSETS

**I Not Improved**—There were 4 cases in this section

*Case*—H C, male, aged 50, seen 10 months after a three-quarter resection for a duodenal ulcer, an antecolic isoperistaltic anastomosis. This man was well for a month after operation, but since then has been completely incapacitated by distension pain after eating and by frequent regurgitations and vomiting of bile

F T M No free acid Diminished total acid Bile present throughout Emptying time  $2\frac{1}{2}$  hours

Blood-count Normal

X-ray examination No ulcer or hold-up (Dr Lawson)

Gastroscopy No ulcer or abnormality seen (Mr McGavin). Is still on a strict ulcer diet. This man is definitely introspective, and it is probably this attitude

which is making his symptoms worse by delaying the normal readjustment of his gastro-intestinal tract. He is slowly improving with reassurance, rest, and sedatives.

*Case*—R H, male, aged 43, seen 3 years 1 month after an isoperistaltic retrocolic resection for gastric ulcer. Ever since his operation this man has had occasional vomits of bile. During the last year, possibly associated with a change of occupation, this is becoming worse, and he is now occasionally vomiting food.

F T M No free acid Low total acid Emptying time 2½ hours

Blood-count Normal  
X-ray examination No evidence of afferent loop regurgitation (Dr Lawson) Is eating normal food This man did not appear to be neurotic

Blood-count Normal  
X-ray examination No evidence of hold up or regurgitation (Dr Lawson) Is eating normal food This man is not neurotic

These four cases will be considered with the next two groups

2 'Improved'—This group of 15 patients had all benefited considerably from their operation, with which they said they were pleased, but all had some symptoms which caused them a certain amount of distress, and which in some cases had caused loss of work for short periods (*Table II*)

All had isoperistaltic anastomoses

No 1 and 15 had a pyloric exclusion

*Table II*—RECORDS OF 'IMPROVED' CASES

	SEX	AGE	ANTE- OR RETRO-COLIC	ORIGINAL LESION	POST-OPERATIVE TIME	FREE ACID	NATURE OF MAIN SYMPTOMS
1 T L	M	38	A	D	2 yr 2 mth	o	Vomiting of bile occasionally Used to be three times a day, but is improving
2 C B	M	36	A	D	1 yr	o	Fullness ++ Has lost work on this account (Is of low intelligence)
3 J B	M	47	A	D	7 mth	Not done	Very occasional vomiting of bile
4 B C	F	48	A	G	3 yr	o	Vague fullness causing very occasional vomiting of food
5 T D	M	33	R	G	5 yr 9 mth	Not done	Fullness, severe enough on occasions to have caused loss of work. (He is aggressive to his stomach, and hurries his food)
6 C G	M	54	R	G	5 yr 9 mth	Not done	Mild fullness Occasional vomiting of bile
7 F P	F	61	R	G	6 yr 5 mth	Not done	Fullness and nausea causing a stay in bed on occasions Bad feeding habits
8 G S	F	42	R	G	4 yr 1 mth	Not done	Distension pain ++ Occasional bile vomits
9 A F	M	44	A	G	1 yr 3 mth	o	Vomiting bile occasionally Slight fullness pain
10 E V	M	42	R	D	1 yr 1 mth	o	Fullness Vomits bile occasionally
11 B F	F	43	R	D	1 yr 7 mth	o	Fullness + Vomits bile sometimes, but with lessening frequency
12 S S	M	46	A	G	1 yr 8 mth	Not done	Feeling of faintness after meals Vomits bile sometimes
13 A H	M	45	A	D	1 yr 1 mth	o	Fullness ++ Occasional vomiting of food
14 W G	M	50	A	G	6 yr 4 mth	o	Vomits bile occasionally Some loss of work
15 J M	M	42	A	D	3 yr 1 mth	—	Very occasional vomiting of bile, at one time this symptom was severe

*Case*—H D, male, aged 45, seen 6 years 8 months after a retrocolic, probably isoperistaltic, resection for gastric ulcer. A definite distension syndrome, persistent since operation, which has probably been aggravated by gross anæmia.

F T M No free acid Low total acid Emptying time ¾ hour

Blood-count 60 per cent Hb, 4,500,000 R B C

X-ray examination No ulceration, no regurgitation, no gastric delay (Dr Lawson) Is eating small frequent meals, attempting to keep to a diet. This man is definitely not neurotic. With iron his anæmia showed rapid regression, at the same time he was advised to increase the bulk of his food, when seen 5 months later he looked very fit and assured me that the uncomfortable feelings after food were much improved.

*Case*—T P, male, aged 37, seen 1 year 1 month after an antecolic isoperistaltic resection for duodenal ulcer, in which a pyloric exclusion with excision of antral mucosa was carried out. A definite distension syndrome. He said that the operation had not benefited him.

F T M 15 c c free acid Low total acid Emptying time 2½ hours

No patient was anæmic

Five were X-rayed and were reported on by Dr Forbes Lawson as follows—

No 9, A F "No ulcer Barium goes into the afferent loop, but there is no obstruction to outflow"

No 13, A H "No ulcer Spasm of stoma at beginning of examination No regurgitation into afferent loop"

No 10, 11, and 14 showed a normally functioning partial gastrectomy

Thus ten of these patients were vomiting bile on occasions, and nine had symptoms of the post-cibal syndrome such as fullness pain, in some cases of distressing degree.

Since this review I have seen two more patients whose recovery is being retarded in like fashion, one is a male 9 months after operation who has bad distension pain, nausea, and a feeling of faintness immediately after eating. He is not improving, and for this reason has been maintaining a strict gastric

diet There is no X-ray evidence of afferent-loop regurgitation, and there is no free acid in his gastric juice He has been reassured and arrangements made for his food to be changed to a more normal constitution

The second patient is a man four months after operation complaining of bile vomiting, which he says is getting worse His was an antiperistaltic anastomosis, there is no abnormality to be found on examination

**3 'Good'**—This group of patients (57) all experienced mild fullness or flatulence after eating, but in none was it a disabling symptom, most of them only gave the information on direct questioning

**Discussion**—It is well known that, soon after operation, patients not uncommonly experience disagreeable sensations on taking food, usually solids, but sometimes liquids It is well to warn the patient of these symptoms and to advise him to build up the volume of his meals gradually, I have recently spoken to two patients not in this series, who, about six weeks after operation, were becoming very worried on account of those symptoms After explanation and advice they improved and are now doing well

Usually, the post-cibal syndrome disappears fairly rapidly, but time does not cure every case, as has been pointed out before by Waugh and others, quoted by Berkman and Heck (1945) Presumably the gastro-intestinal tract becomes accustomed to the new conditions, and Berkman and Heck raise the point that in order that the stomach and jejunum may become accustomed to normal food it is important that the diet of these patients should be gradually but surely changed from the soft non-irritating gastric-diet foods to the more bulky foods of a normal diet, and that they should not be deterred from doing so by the post-cibal sensations They also maintain the importance of a sufficient calorie intake in the immediate post-operative period in order to ensure the well-being of the patient, and speed his recovery

Few writers have mentioned bile vomiting as a symptom after gastrectomy, but many have noted the post-cibal syndrome of fullness and wind, a heavy feeling in the epigastrium, sometimes nausea, with fainting or sweating, and some, e.g., Berkman and Heck, have pointed out that this syndrome may be more disabling than recurrent ulceration, as it was in 4 cases in this series In the present group of cases bile vomiting was noted in 12, and fullness, sweating, etc., in 68 in varying degrees

There are three possible causes for the post-cibal syndrome (1) The small size of the stomach stump (2) Reflux into the afferent jejunal loop (3) 'Dumping' into the jejunum

**The Size of the Stomach**—Distension of the apparently small stomach stump is, I believe, usually not the cause of symptoms for the following reasons I have observed identical symptoms in 4 patients after total gastrectomy Many observations after gastrectomy have pointed out the great speed with which the stomach empties Hence, in this series, 31 of 45 fractional test-meals have indicated complete emptying in not more than 1½ hours

Dr Forbes Lawson has not seen any evidence of gastric delay in the cases in this series, although all

these patients who were X-rayed had symptoms suggestive of possible delay

Vitkin (1940) says that the stomach is empty in 20 minutes, often sooner Strauss and others (1930) say that in their series an emptying time of less than 50 minutes is usually present

Shanks says that all partial gastrectomies empty more rapidly than the normal stomach, the Polya being most rapid

Schmidt and Melick (1945) mention "immediate emptying" in 17 of 21 cases examined radiographically Further, there is much evidence that the stomach stump will expand and approach the size of an 'average' stomach, if there exists such a stomach Thus in this series the stomach has been usually seen to be of "reasonable" size Shanks gives an X-ray picture after a Polya-Lake gastrectomy in which the stomach is quite large, and Vitkin says that at the end of one year only 9 of 45 patients examined radiographically had a stomach smaller than 'average' size

In this review only a few patients stated that their meals were of necessity of smaller volume than normal, although many restricted the volume of food in order to lessen the post-cibal symptoms By so doing they managed to lead to all intents and purposes a normal life

**Reflux to the Afferent Loop**—Many surgeons believe that the post-cibal syndrome is due to reflux of food into the duodenum and afferent loop (Ogilvie, 1935, Lake, 1937, Maingot, 1940, Marshall, 1944, Wangenstein, 1945, Ingelfinger, 1945, Monro, 1945)

Undoubtedly duodenal reflux is of common occurrence, but in the absence of obstruction to the outlet of the afferent loop, it does not give rise to symptoms Radiologists have frequently noted the backflow without obstruction and have seen that the duodenum is of normal calibre In cases where this backflow is the cause of post-cibal distension and vomiting, there is a mechanical obstruction to the outflow from the afferent loop, due to faulty technique, usually in using too short a loop, or in twisting the loop, or obstruction on passing through the mesocolon in a retrocolic anastomosis The surgeons mentioned above and many others (Lahey and Marshall, Richter, Kiefer, Finsterer, and Cunha) use the Finsterer-Hofmeister modification whereby about half of the cut end of the stomach is closed, leaving a smaller stoma near the greater curvature, for anastomosis to the efferent jejunal loop The afferent loop is hitched to the lesser curve By this means these surgeons believe reflux into the afferent loop is rendered much less likely

In this particular series I do not believe that the afferent loop reflux has been the cause of symptoms, for the following reasons The discomfort has always been central epigastric, rather than on the right side, there has been X-ray evidence of reflux without obstruction to outflow in one case only, despite the fact that some degree of reflux is a not uncommon normal finding, where vomiting has occurred, food has rarely been seen

I have, however, recently seen one patient not included in this series, since his operation was only four months old, whose present symptoms are due to afferent-loop obstruction He had an antecolic

isoperistaltic Polya gastrectomy for gastric ulcer, and said that he was well for one month after operation, but then began to vomit each morning, usually one hour after a glass of milk, the vomit consisting of half a pint or more of bright-green fluid, not containing food, and not recurring at other times of the day. X-ray examination by Dr. Lawson revealed distension of the afferent loop without complete obstruction, but resulting in some delay in the progress of the meal, he noted a suggestion that the jejunal segment was perhaps twisted. It will be noticed that this man's symptoms are rather different to those of the usual post-cibal syndrome.

*Jejunal 'Dumping'*—This is, to-day, the commonly accepted cause of most of the unpleasant symptoms after gastrectomy. Samson Wright, discussing the effect of distension of the upper jejunum, says that symptoms similar to those caused by distension of the duodenum are produced. "There is a sensation of pressure, dull and heavy in character, deep seated and poorly localized anteriorly between the xiphoid and umbilicus, at still higher pressure there is a disagreeable painful or graping feeling."

The description of this sensation is very similar indeed to that given by a number of the patients interviewed, and I believe that it is the sudden entry of food in fairly large quantities which mimics these experiments and causes upsets in some patients, we do know that the stomach, as a rule, empties rapidly. This sensation certainly distresses some patients in early post-operative times, even when they are warned about the possibility as they should be. It is also often accompanied by vasomotor phenomena which Samson Wright also describes.

That the post-cibal syndrome is not to be dismissed lightly, and that the figures in this series represent its approximate incidence, are shown by reference to other series. Berkman and Heck (1945) quote several sets of figures, e.g., Mateer 14 per cent, "not infrequently" in 240 cases by Muller, "sufficient numbers to be noticeable" in 104 cases by Church and Hinton, 5.6 per cent and 12.5 per cent in large series by Carter, Butt, and Waugh. Ingelfinger (1944) says that probably 10 per cent of patients suffer the post-cibal syndrome, although he points out that the published figures vary considerably.

Since it is not possible to re-form a sphincter after partial gastric resection, it is suggested that possibly a reconstruction of the Hofmeister-Finsterer valve type might help to do away with some of this jejunal dumping, by narrowing the entrance to the jejunum and offering a purely mechanical barrier to the rapid filling of the bowel.

In looking through the literature, I have come across the following references to clinical results in regard to size of stoma. As far as I have been able to ascertain, the figures quoted by Berkman and Heck referred to results in the Polya 'wide-stoma' anastomosis. Morlev (1928) remarks that he finds the Schoemaker operation to give better "clinical results" than the Polya. Louria (1928) mentions 128 excellent results out of 158 gastrectomies, which were of the Billroth I or II type. 25 patients complained of fullness but were greatly improved, only 5 were not improved. Finsterer and Cunha (1931), using the Hofmeister method, quote out of 307

cases only 4 who experienced gastric distress. The whole group were more than three years post-operation.

Ogilvie (1935) has not seen "post-operative vomiting or distension even in a minor degree" in over 100 anastomoses of the Finsterer type. He had previously remarked upon its not infrequent occurrence after a full-width anastomotic line.

Ingelfinger (1944) says 10 per cent of patients suffer the post-cibal syndrome, although he thinks that the size of the stoma plays very little part in the picture, but that ability of the bowel to adjust itself is more important.

Marshall (1944) says that the Polya-Moynihan operation is commonly followed by 'dumping' into the jejunum and duodenal reflux. He says the stoma should be a little larger than gut calibre, and fashioned in a Hofmeister anastomosis.

Pallis (1932) attributes many unsatisfactory results after the Billroth II to precipitate emptying of the stomach. He says that the Billroth I is superior on these grounds.

In Vitkin's cases, where the incidence of post-operative symptoms was low, the anastomosis was of the Hofmeister type. Vitkin says that in this group it was very often noticed that the first of the barium meal went straight into the afferent loop, but that the remainder was to some extent held in the stomach, and evacuated rhythmically, mainly due to bowel peristalsis.

Waugh, quoted by Berkman and Heck (1945), had recently used the Hofmeister valve modification of the Polya in a few cases, and had an impression that the results were better than the full-width type of stoma which he had previously used.

Mangot (1945) uses the Polya-Hofmeister operation for several reasons, one of which is that "post-operative obstructive symptoms and the sensation of fullness after meals are obviated."

*Bile Vomiting*—I believe that it is the rapid emptying of the stomach due to the size of the anastomosis which is responsible for the vomiting of bile in some of these patients. The response of the gall-bladder to the ingestion of food is a contraction almost immediately, in a Polya anastomosis, by the time this bile reaches the stomach, it is empty, and it would appear that in some patients, bile acts as a strong irritant to the gastric mucosa, leading to regurgitation and vomiting, in this series only very rarely was food vomited with bile.

References to this type of upset in the literature are few, but McClure and Fallis (1940, a, b) say the Hofmeister-Finsterer-valve technique is of value in deflecting upper intestinal contents past the gastric stoma, they have gained confirmation of this impression by the fact that a good deal less bile is aspirated post-operatively when this type of anastomosis is used. This observation agrees with my own personal knowledge of this type of anastomosis. They also say that "since adopting this technique our patients have not complained of occasional regurgitation of bile, as not infrequently occurs during convalescence after the Polya operation."

It is realized that the figures quoted above are by no means conclusive in showing that a small stoma may improve some of the bad end-results after gastrectomy, and the picture is further complicated

by recent work mentioned previously, which suggests that interference with pressure gradients between stomach and small bowel may be a main factor in dealing with the post-cibal syndrome. Nevertheless, I feel that investigation on similar lines of a fairly large series of cases, using a small anastomosis, would be very useful.

### THE FRACTIONAL TEST-MEAL

Seventy-one fractional test-meals have been carried out in the course of this review. The test is carried out after a fast for twelve hours, the fasting juice is then aspirated, after which a pint of gruel is drunk and the stomach contents aspirated every quarter of an hour. It has been the practice to stimulate the flow of hydrochloric acid by the injection subcutaneously of 0.0001 mg. of histamine should the fourth specimen of juice fail to contain free acid.

Certain features have been common to all the test-meals. Mucus has been present in all specimens in all cases. Bile has been present in all specimens in most of the cases. All have shown a lowered total acidity, indicating an actual diminution in the quantity of gastric juice secreted.

The test-meals are divisible into two main groups: 49 in which the ulcer, whether gastric or duodenal, was removed completely, I have called these 'routine' gastrectomies. The other group consists of 22 in which the modern modification of pyloric exclusion for duodenal ulcer has been carried out.

**Forty-nine Test-meals after Routine Gastrectomy**—The findings in this group have confirmed the usual findings after partial gastrectomy, i.e., most of the cases have failed to show the presence of free hydrochloric acid and all have shown a diminished total acidity. Only 7 showed free acid (Table III, Fig. 511).

Table III—CASES SHOWING FREE ACID AFTER PARTIAL GASTRECTOMY

NAME	SEX	AGE	ORIGINAL LESION	POST-OPERATIVE TIME	HIGHEST FREE TOTAL ACID	CLINICAL RESULT
C B	F	48	Gastric	7 mth	10/25 cc	Good
C B	M	38	Duodenal	1 yr	5/25 cc	Improved
A M	F	67	Pyloric	1 yr 7 mth	10/28 cc	Good
H S	M	49	Duodenal	2 yr 11 mth	5/22 cc	Good
V R	F	48	Duodenal	3 yr 3 mth	20/35 cc	Good
C Br	M	56	Duodenal	3 yr 9 mth	12/20 cc	Excellent
W M	M	47	Gastric	6 yr 10 mth	8/35 cc	Excellent

The remaining 42 are listed in Table IV, and are typically illustrated by the two graphs, Figs 512, 513.

Several points emerge from these figures—

Despite the well-known fact that a duodenal ulcer is usually associated with a much higher acidity than a gastric ulcer, the remnant of stomach after operation does not appear to behave differently in the two types. It must be agreed, however, that the test-meal is not a very accurate estimation.

Length of time after operation would appear to make no difference to the acid-secreting capabilities of these post-operation stomachs. Most of the

results indicate rapid emptying, but there does not appear to be any relation between the rate of emptying and the functional result.

Table IV—TEST-MEALS IN THE REMAINING 42 CASES

NAME	SEX	AGE	POST-OPERATIVE TIME	HIGHEST TOTAL ACID	EMPTYING TIME	CLINICAL RESULT
After Gastrectomy for Gastric Ulcer —						
G B	M	65	1 yr 1 mth	32 cc	1 hr	Good
A F	M	41	1 yr 3 mth	35 cc	1 hr	Improved
M W	F	60	1 yr 4 mth	28 cc	1 hr	Good
J D	M	45	1 yr 5 mth	32 cc	1 hr	Good
J D	M	44	1 yr 6 mth	13 cc	1 hr	Good
A C	M	63	1 yr 10 mth	18 cc	1 hr	Excellent
J J	M	56	2 yr 1 mth	22 cc	2 hr	Good
P B	M	35	2 yr 4 mth	25 cc	1 hr	Good
T H	M	67	2 yr 4 mth	10 cc	1 hr	Good
G R	M	69	2 yr 9 mth	22 cc	1 hr	Excellent
L S	F	42	2 yr 10 mth	28 cc	1 hr	Excellent
B C	F	51	3 yr	25 cc	1 hr	Improved
R H	M	42	3 yr 1 mth	22 cc	2 hr	Not improved
K F	F	60	3 yr 7 mth	31 cc	1 hr	Good
S P	M	49	3 yr 8 mth	20 cc	1 hr	Good
W D	M	51	4 yr 1 mth	22 cc	1 hr	Good
A S	M	66	4 yr 3 mth	20 cc	1 hr	Good
W T	M	56	4 yr 5 mth	27 cc	1 hr	Good
W G	M	57	6 yr 4 mth	25 cc	1 hr	? Improved
H D	M	39	6 yr 8 mth	30 cc	1 hr	Not improved
E W	F	55	7 yr 5 mth	20 cc	1 hr	Excellent
After Gastrectomy for Duodenal Ulcer —						
A H	M	46	1 yr	45 cc	1 hr	Improved
H C	M	50	10 mth	22 cc	2 hr	Not improved
E K	M	44	1 yr 2 mth	15 cc	1 hr	Improved
A F	M	51	1 yr 3 mth	15 cc	1 hr	Excellent
A L	M	41	1 yr 4 mth	18 cc	2 hr	Good
M Q	M	35	1 yr 6 mth	22 cc	1 hr	Excellent
A F	F	45	1 yr 7 mth	20 cc	1 hr	Improved
C M	M	41	1 yr 7 mth	32 cc	2 hr	Excellent
H W	M	50	1 yr 8 mth	23 cc	1 hr	Recurrence
E T	M	41	1 yr 9 mth	25 cc	1 hr	Excellent
M G	F	47	2 yr	23 cc	2 hr	Good
A B	M	51	2 yr	20 cc	1 hr	Good
E C	F	43	2 yr 1 mth	30 cc	2 hr	Good
G D	M	45	2 yr 3 mth	27 cc	2 hr	Excellent
H B	M	42	3 yr 5 mth	27 cc	1 hr	Good
W W	M	45	3 yr 10 mth	30 cc	1 hr	Good
C M	M	42	4 yr	12 cc	1 hr	Recurrence
H B	M	39	4 yr 4 mth	27 cc	1 hr	Good
C B	M	46	6 yr	12 cc	1 hr	Good
C P	M	42	6 yr 9 mth	15 cc	1 hr	Good
After Stomal Ulcer —						
S H	M	51	1 yr 6 mth	30 cc	1 hr	Good

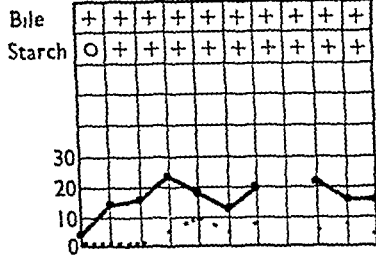
**Twenty-two Test-meals after Gastrectomy with Pyloric Exclusion**—This operation is the modern derivative of the method originally devised by Finsterer in 1918 for use where the state of the duodenum rendered removal of the ulcer dangerous. It now consists of division of the stomach through the pyloric antrum, preservation of the seromuscular layer, and excision of the mucosa as far as the sphincter, the ulcer being left in situ.

Of the 22 test-meals, 14 have shown the presence of free acid (Fig. 514). In addition to this high incidence of free acid, the other interesting feature is that most of them show a much higher quantity of both free and total acid when compared with those test-meals showing free acid after routine gastrectomy.

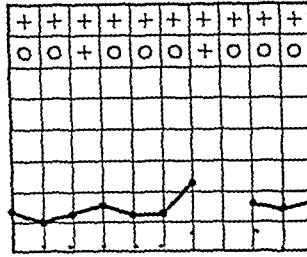
Table IV shows the results in this group.

**The Results of the Operation of Pyloric Exclusion (Table VI)**—The fractional test-meals after pyloric exclusion are at such variance with those following routine gastrectomy that one feels that they must have some significance. If one believes that

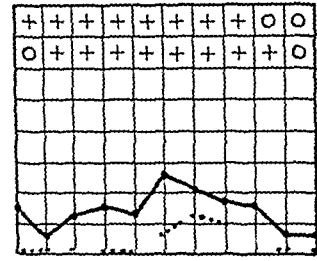
Time 0  $\frac{1}{4}$   $\frac{1}{2}$   $\frac{3}{4}$  1  $1\frac{1}{4}$   $1\frac{1}{2}$   $1\frac{3}{4}$  2  $2\frac{1}{4}$   $2\frac{1}{2}$  hr



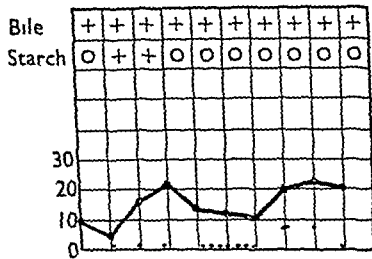
C B (F) Gastric, 7 mth



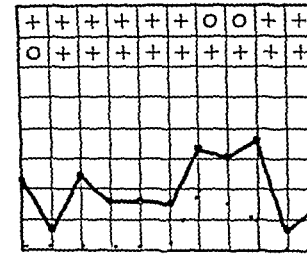
C B (M) Duodenal, 1 yr



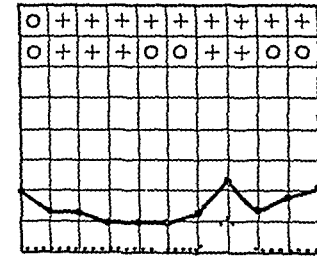
A M (F) Gastric 1 yr 7 mth



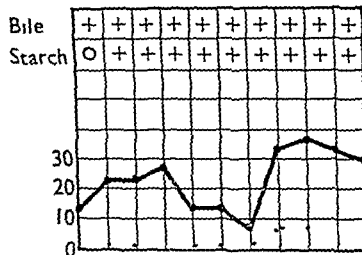
H S (M) Duodenal, 2 yr 11 mth



V R (F) Duodenal, 3 yr 3 mth



C Br (M) Duodenal, 3 yr 9 mth



W M (M) Gastric, 6 yr 10 mth

Acidity is expressed as c c N/10 NaOH

Continuous line = Total acid

Dotted line = Free acid

FIG 511—Fractional test-meal charts of seven patients after 'routine' partial gastrectomy, showing free acid

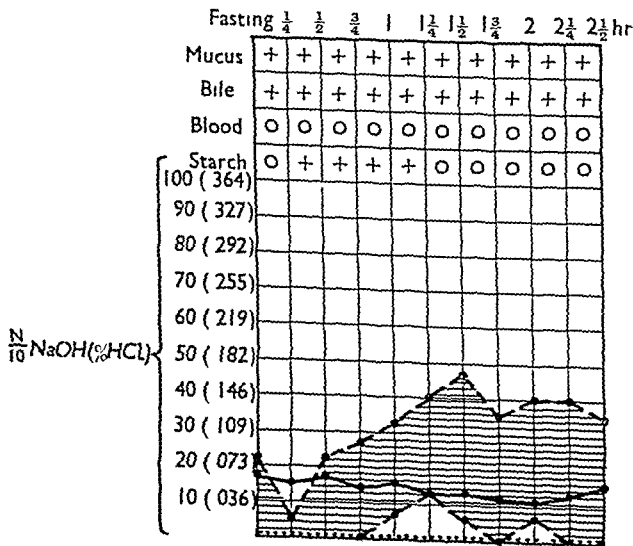


FIG 512—A H, male, 63 years Gastric ulcer 1 yr 10 mth post-operation

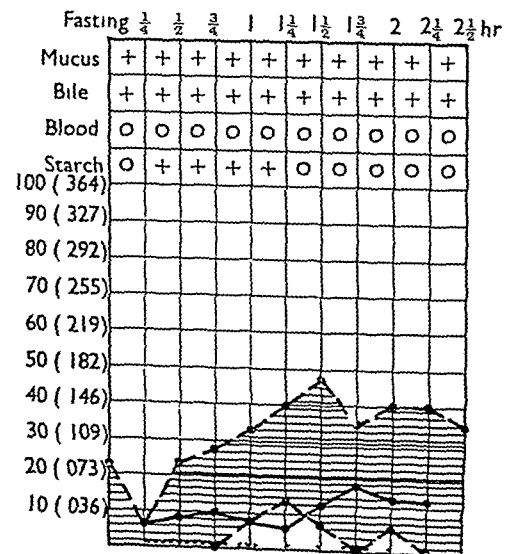
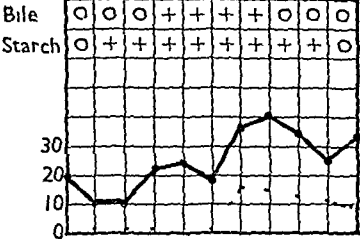
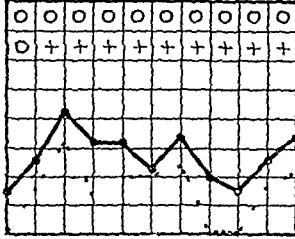


FIG 513—C P, male, 42 years Duodenal ulcer 6 yr 9 mth post-operation

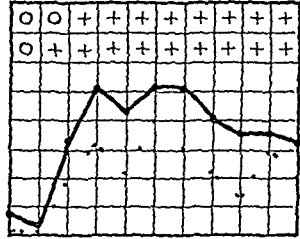
Time (hours) 0  $\frac{1}{4}$   $\frac{1}{2}$   $\frac{3}{4}$  1  $1\frac{1}{4}$   $1\frac{1}{2}$   $1\frac{3}{4}$  2  $2\frac{1}{4}$   $2\frac{1}{2}$



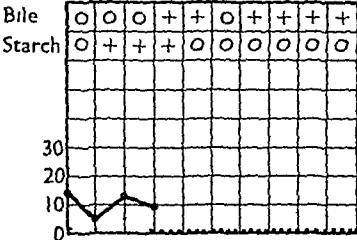
J G (M) 7 mth



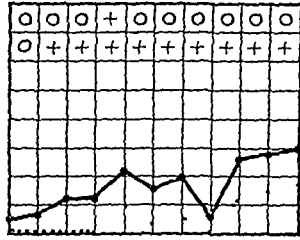
W B (M) 8 mth



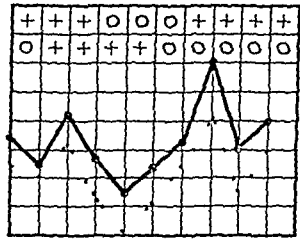
S B (M) 9 mth



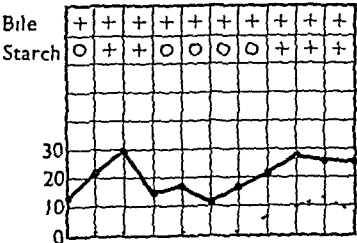
G B (M) 1 yr



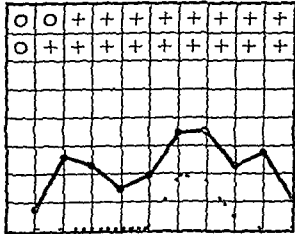
T P (M) 1 yr 1 mth



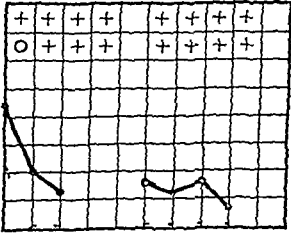
W W (M) 1 yr 1 mth



C H (M) 1 yr 2 mth

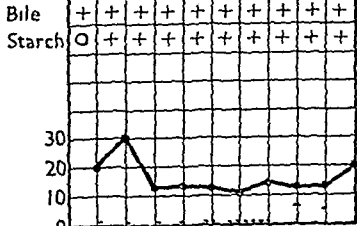


J W (M) 1 yr 3 mth

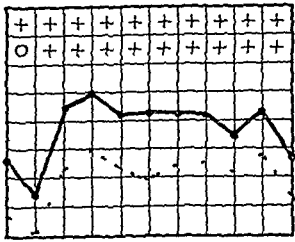


R T (M) 1 yr 3 mth

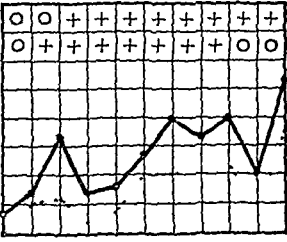
Time (hours) 0  $\frac{1}{4}$   $\frac{1}{2}$   $\frac{3}{4}$  1  $1\frac{1}{4}$   $1\frac{1}{2}$   $1\frac{3}{4}$  2  $2\frac{1}{4}$   $2\frac{1}{2}$



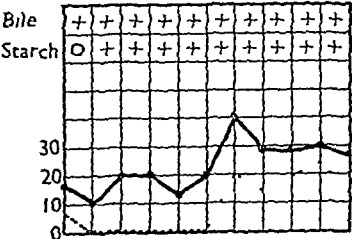
H L (M) 1 yr 6 mth



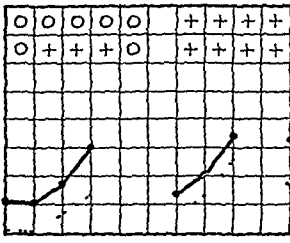
A C (M) 1 yr 9 mth



L McD (M) 1 yr 9 mth



J R (M) 2 yr



C P (M) 3 yr

Acidity expressed as  
cc N/10 NaOH  
Continuous line = Total acid  
Dotted line = Free acid

recurrence of ulceration is at least associated with the presence of free hydrochloric acid, then one might say that the incidence of recurrence in this group would be higher. Fortunately this seems not to be

Table V—DETAILS OF 22 CASES AFTER GASTRECTOMY WITH PYLORIC EXCLUSION

POST-OPERATIVE TIME	HIGHEST FREE TOTAL ACID	CLINICAL RESULT	EMPTYING TIME
14 Cases with Free Acid (all males) —			
7 mth	18/40 cc	Improved	2½ hr +
8 mth	30/40 cc	Very good	2½ hr +
9 mth	40/55 cc	Excellent	2½ hr +
1 yr	5/15 cc	Excellent	1 hr
1 yr 1 mth	15/30 cc	Poor	2½ hr +
1 yr 1 mth	45/60 cc	Very good	1½ hr
1 yr 2 mth	10/30 cc	Excellent	2½ hr +
1 yr 3 mth	20/37 cc	Excellent	2½ hr +
1 yr 3 mth	20/42 cc	Good	2½ hr
1 yr 6 mth	5/30 cc	Very good	2½ hr +
1 yr 9 mth	30/50 cc	Very good	2½ hr +
1 yr 9 mth	38/52 cc	Excellent	2 hr
2 yr	22/40 cc	Good	2½ hr
3 yr	20/35 cc	Recurrence	2½ hr +
8 Cases without Free Acid (all males) —			
10 mth	32 cc	Very good	1 hr
1 yr 3 mth	10 cc	Good	2 hr
1 yr 4 mth	12 cc	Excellent	1½ hr
1 yr 7 mth	20 cc	Excellent	1½ hr
2 yr 2 mth	40 cc	Improved	1½ hr
2 yr 4 mth	28 cc	Good	½ hr
2 yr 8 mth	23 cc	Good	1½ hr
2 yr 10 mth	25 cc	Excellent	1½ hr

so, although most of the cases are of fairly recent post-operation date

Table VI—RESULTS IN 30 CASES AFTER PYLORIC EXCLUSION

Excellent	14	46.7 per cent
Good	11	36.7 per cent
Improved	3	10 per cent
Not improved	1	3.3 per cent
Recurrence	1	3.3 per cent

All modern writers are agreed that Finsterer's original method of pyloric exclusion whereby the mucosa of the pyloric antrum is preserved is bad, not only is it technically difficult, but it is dangerous should pyloric stenosis occur, and it is physiologically unsound since it preserves that area of mucosa which is the main source of the hormone gastrin, the chief acid-secreting stimulus. Hence the modern operation (Finsterer, 1931, Ogilvie, 1938, Mangot, 1941) of division through the pyloric antrum and excision of the pyloric mucosa has been devised, with, apparently, great success.

Thus Mangot quotes only 2 per cent of recurrences after this operation, he does not indicate the frequency of free hydrochloric acid. Finsterer and Cunha (1939) quote a similar figure, but again make no reference to acidity. Walton (1941) believes that division of the duodenum beyond the ulcer is not necessary. Lannin (1945) gives experimental evidence in dogs that removal of the duodenal mucosa is of no great significance provided the antral mucosa is removed. Wangenstein (1945) says that his observations suggest that it is not necessary to remove the duodenal ulcer itself to prevent ulcer recurrence. It seems that there are two possible reasons for the higher incidence of free acid in this group of cases. The more likely is that not all the

mucosa of the pyloric antrum has been removed, this had definitely occurred in a case of recurrent ulceration reported by Wangenstein, in which the ulceration had remained healed for five years following excision of the fragment of mucosa.

Another possible reason is that in these cases the whole of the first part of the duodenum is preserved, whereas in the routine gastrectomy probably more than half is removed or destroyed. Samson Wright says that the hormone gastrin is manufactured in the duodenum, presumably this would occur in the first part.

Should the good results of this group of cases be maintained, as seems possible from a review of the literature and from the small number of cases in this series over two years after operation, then at least it will definitely do away with the common belief that free acid is a usual precursor of recurrent ulceration after gastrectomy. Holmes and McSwain, for instance, say "up to the present time all marginal ulcers in this clinic occurred in patients with adequate (post-operative) acidity." In Kiefer's series of 20 recurrences after gastrectomy, free acid was present in 17.

**Conclusion**—The presence of this free acid is rather alarming, and suggests that until we know more about the exact role of free acid in peptic ulceration, pyloric exclusion should not become a routine operation. The operation is undoubtedly a great help, and has contributed a large share to lowering the mortality in duodenal ulceration, yet one feels that possibly six to eight weeks' strict medical therapy before operation in patients with much pain, by lessening the inflammatory reaction around the active ulcer, and by lessening the formation of adhesions, would render the complete removal of a duodenal ulcer a more practicable procedure, and thereby might help to lower the incidence of the necessity for this type of gastrectomy.

Should the fear of recurrent ulceration in this group of cases be found to be real, as time will define, then the operation of pyloric exclusion would still have a prominent place in the treatment of duodenal ulcer. The surgical treatment would then consist of a two-stage procedure in which the first stage would be a high gastrectomy with the old-type pyloric exclusion, to be followed after an interval of a few weeks by resection of the pylorus and duodenum. A very successful series of this type has recently been reported by McKittrick, Moore, and Warren (1944). They said that six to twelve weeks after the first stage the duodenum had healed and settled down and could be excised easily.

### ANÆMIA

The standards for normal hæmoglobin and red blood-cells are those adopted by Whitby and Britton (1940) as follows —

Hæmoglobin is expressed as a percentage according to the Haldane scale (13.8 g Hb per cent)

Lowest normal for the male	100 per cent Hb
	5,000,000 R B C
Lowest normal for the female	85 per cent Hb
	4,500,000 R B C

On these values, 17 out of 127 patients examined were found to be anæmic. Of these 17, 3 have been



excluded, since they were suffering from other conditions which were almost certainly causing their anæmia—two men with hæmorrhoids, and one woman with menorrhagia due to fibroids, one of the men is known to be improving after treatment for his hæmorrhoids. This gives an incidence of 14 in 127, i.e., 11 per cent.

The sex incidence is as follows —

Males	10 of 107 (9.3 per cent)
Females	4 of 20 (20.0 per cent)

All except one of these anæmias were of the hypochromic microcytic variety. The one appeared at first to be a pernicious anæmia in that the colour index was high and the cells appeared large, there were, however, no abnormal red cells to be seen, and his ready response to iron confirmed the opinion that he was an unusual form of iron-deficiency anæmia.

Four, two men and two women, of the 14 might be described as severe anæmias, having hæmoglobin less than 60 per cent.

The cases have been divided by the three years' post-operation time into the following two groups —  
*Longer than Three Years' Post-operation —*

Original lesion	Duodenal	Gastric	Stomal
No of cases	13	23	1
No of anæmias	2	5	0

i.e., of 37 cases, 7 were anæmic (18.1 per cent).

The four severe anæmias were in this group.  
*Less than Three Years' Post-operation —*

Original lesion	Duodenal	Gastric	Stomal
No of cases	50	36	4
No of anæmias	1	6	0

i.e., of 90 cases, 7 were anæmic (7.7 per cent).

The tables do support the clinical impression that the anæmia is of slow progress and likely to become severe in later years.

Another interesting feature is that 11 of the 14 anæmias were in-patients originally suffering from a gastric ulcer, as follows —

Duodenal	63	Gastric	59
Anæmias	3 (4.7 per cent)	Anæmias	11 (18.8 per cent)

All 14 anæmic patients had no complaints as regards their anæmia except 1, a woman who had been referred to hospital on account of dysphagia and shortness of breath.

**Clinical Picture**—The impression gained on seeing these patients and their blood-counts is of a very slow but definite progress of anæmia, its slowness renders it hardly noticeable at all to the patient, as witness the man, W. M., aged 39, a farm labourer, who presented a most interesting picture, he had been working hard since his operation nearly seven years ago, and indeed appeared on examination to be fairly well except for a slight pallor, his hæmoglobin was found to be 26 per cent. He improved amazingly on treatment with iron for a short time.

Ten patients were eating normal food, 4 said they were on a 'diet'. Investigation of two of the diets by the dietitian indicated that they were not deficient in iron-containing food. Three of these had maintained their diet for over six years and

their hæmoglobins were three of the lowest—38 per cent (female), 20 per cent (male), 58 per cent (male). The fourth of the severe anæmias, 49 per cent (female), had been dieting for over two years post-operatively. Despite the dietitian's investigation of two of these cases there does seem to be a predisposing factor here. Monro (1945) says that anæmia is almost unknown since recognition of the fact that post-operative dieting is not necessary.

**Free Acid in Fractional Test-meal**—Of the 14 patients showing anæmia, fractional test-meals were carried out on 13, 3 showed the presence of free acid, two of them in patients with hæmoglobin of 49 per cent (female) and 26 per cent (male). All other fractional test-meals showed a reduction in the total chlorides, indicating at least a reduction in total acid secretion, even though not necessarily complete anacidity.

**Response to Iron**—The response to iron has been remarkable. Nine patients have been observed and all have shown an extremely good and rapid response to iron, either as ferrous sulphate or as ferri et ammonium citrate, within a short period—usually an obvious reticulocyte response has been observed within a month.

The above observations indicate a disadvantage of the Polya operation, in that despite the secretion of free acid, its good value as regards the absorption of iron is immediately lost by very rapid neutralization by intestinal secretions, as evidenced by the invariable presence of bile in fasting juices, and do suggest that, in order that the small quantity of iron necessary to prevent anæmia shall be absorbed, the food of these patients has to contain a relatively high quota of iron, an indication for getting the patient on to a normal diet as soon as possible.

**Pre-operative Anæmia**—Morley (1928), discussing anæmia after gastrectomy for gastric ulcer, says "This tendency to anæmia was most noticeable in those who were anæmic at the time of operation as a result of pre-operative hæmatemesis."

The figures of pre-operative anæmia in this series, where known, are shown below, the relation to previous hæmatemesis is not known, only one was severe, most of them having been dealt with by blood transfusion pre-operatively.

Not anæmic before operation	96	Post-operation anæmia	5 (5.3 per cent)
Anæmic before operation	20 (one severe)	Post-operation anæmia	7 (35 per cent)

These figures support Morley's suggestion that pre-operation anæmia constitutes a handicap to recovery of a normal blood-count—they do show, however, that a pre-operation anæmia can be recovered from, a fact which had already been noted after examination of some immediate post-operation blood-counts which were low, and which had shown a rise to normal when examined.

**Clinical Results in Anæmic Patients**—The clinical results were as follows —

Excellent	4
Good	7
Improved	0
Not improved	1
Recurrence	1

These agree with most of the results recorded in the literature, i.e., that the functional element of the stomach is independent of the blood-picture, although in two cases (C M, a recurrence, H D, not improved) the anæmia did appear to be aggravating the gastro-intestinal upset. The latter's symptoms improved considerably when his anæmia was treated.

**Review**—Since Deganello in 1900 reported a case of microcytic anæmia after an almost total gastrectomy, anæmia has been to the fore as a complication of gastric operations, especially resection. A review of the literature reveals two features about this complication after partial gastrectomy for simple ulcer: (1) Pernicious anæmia is rare, (2) The incidence of hypochromic anæmia varies considerably in different series of cases.

**Pernicious Anæmia**—Lake (1937) found no cases of pernicious anæmia in over 300 partial gastrectomies, Ogilvie (1935) none in 140, Vaughan (1932) quotes only 9 cases recorded up to that date. In this series there were no cases in 127.

Other series also indicate the very occasional occurrence of this variety, and the incidence is so low as to suggest that its presence is often probably coincidental.

**Hypochromic Anæmia**—Has long been recognized as a complication after an otherwise successful partial gastrectomy, but the records give a confusing idea of the incidence, thus—

Gordon-Taylor	(1928)	23 out of 52 cases
Morley	(1928-9)	16 out of 42 cases
Strauss et al	(1930)	1 out of 221 cases
Berg	(1930)	0 out of 400 cases
Louria	(1928)	None were mentioned in 129 cases
Larsen	(1934)	31 out of 86 cases
Reider	(1934)	39 out of 162 cases
Ogilvie	(1935)	No cause for investigation re anæmia in 140 cases
Semb	(1937)	25 per cent in males, 70 per cent in females (250 cases)
Lake	(1937)	Over 300 cases, 'mild microcytic anæmia follows in some cases'
Manizade	(1937)	2 out of 40 (all over 5 years after operation)
Ingelfinger	(1944)	'Hypochromic anæmia is not uncommon'
Present series	(1946)	14 out of 127 cases (11 per cent)

I believe that the figure of approximately 10 per cent in the present series indicates the probable incidence. It seems likely that the insidious progress of the anæmia has caused it to pass without notice in some of the above series.

Morley believes that the Polya operation causes a higher percentage of anæmias than does the Schœemaker type. This is to be expected when the absorption of iron from the gastro-intestinal tract is considered, iron is absorbed from the least alkaline part, i.e., the first half, of the duodenum. Other writers, e.g., Larsen (1934) and Reider (1934), have not noted the discrepancy between the two types of operation. Incidentally, Morley's and Gordon-Taylor's series in which the anæmia was common, both consisted mainly of operations for gastric ulcers. The present series does not support this condemnation of the Polya operation for all types of ulcer, but certainly does give that idea when considered as the operation for gastric ulcer. The suggestion I have to offer for this discrepancy between duodenal

and gastric ulcer results is connected with the usual difference in the amounts of free hydrochloric acid found pre-operatively in the two groups of cases.

Test-meals have shown no increased secretion of free or total acid in the duodenal cases, however, the post-operative fractional test-meals in the Polya operation can only be a coarse guide to the presence of acid, it is easy for the tube to withdraw jejunal secretion, and it would seem to me that the stomach of a duodenal ulcer post-operatively would still tend to secrete more acid than a similar remnant of a stomach from a gastric ulcer. Some writers, e.g., Holman and McSwain, have noted a difference in the two groups, 'duodenal' stomach remnants having been the chief offenders in secreting acid.

**Summary**—Hypochromic anæmia is definitely a complication of partial gastrectomy, but not sufficiently frequent to cause the operation to be condemned on that account. It is more common after gastric ulcer.

Is almost always of the microcytic type.

Is usually of mild degree but may become severe if not treated.

Whether mild or severe, response to iron is excellent.

Diet for prolonged periods may be a predisposing factor.

The anæmia is insidious and often causes no complaints.

Females are more prone than males.

Is not related to the presence or absence of free hydrochloric acid.

Pre-operative anæmia is not irrecoverable.

The clinical result does not depend upon the blood-picture.

It behoves the practitioner to be well aware of the possibility of anæmia in a patient after a Polya gastrectomy for gastric ulcer.

## CONCLUSION

In looking through this collection of cases and the literature, as has just been done, one realizes that whilst partial gastrectomy has been, and must for some time continue to be, a great boon to a very large number of patients, there is still a residuum of cases after this operation which are not improved. Some suffer intensely from the post-cibal syndrome, and I have attempted to show that perhaps the small stoma will still further lessen this group.

Other cases suffer recurrent ulceration, and whilst the amount of stomach to be removed has not been discussed, I believe it should not be less than 60 per cent, the question of the length of loop needs further investigation clinically, but there is evidence to suggest that the shorter the loop, the greater the safety from ulceration.

The operation of pyloric exclusion even in its modern form is still not free from criticism from the point of view of post-operative acidity.

Anæmia has long been held up as a major complication after partial gastrectomy, and I hope that the cases in this series will have reduced this bogey to its correct lowly place.

I wish to thank all the members of the staff of the Leicester Royal Infirmary for permission to use their cases, and for the help they have given me.

Particularly I would like to express my gratitude to Mr D McGavin for his personal encouragement and help

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## PROFESSOR G GREY TURNER AT THE POST-GRADUATE MEDICAL SCHOOL

IN the January number of the BRITISH JOURNAL OF SURGERY for 1937 a visit to Professor Grey Turner at the British Post-graduate Medical School was described. In the ten years' interval much has happened in the world of medical organization and education. There has probably never been a time when all classes of the community have been more interested in the numerous problems which can be summed up in the words "National Health".

It is at such a moment that in the fullness of time Professor G Grey Turner, the first occupant, has retired from the professorial chair in surgery at the Post-graduate School in the University of London.

It is an appropriate time for a younger man to undertake the arduous duties, and, fortunately for him, he will have the experience of his predecessor to draw upon.

The war years will have prevented the fulfilment of many cherished schemes, for which lack of staff, difficulties of replacement, and many other things have presented unsurmountable difficulties.

The "Goodenough" report rightly stresses the two broad necessities for post-graduate medical education, viz (1) Facilities for post-graduate medical education and experience for those wishing to become "Specialists", (2) Other forms of post-graduate education, including refresher courses for general practitioners.

The latter can probably be best obtained at what will in future be District General Hospitals, whereas the former would be best catered for at a post-graduate medical college in London or similar institution in the provinces associated with the University regional headquarters. These may be

necessary in addition to the undergraduate schools as there is an inherent difficulty in mixing undergraduate and post-graduate education.

London, with its twelve scattered undergraduate medical schools, is, however, fortunate in that with adequate planning its post-graduate education can be centralized, if only the will to do this is present.

For those wishing to become specialists in medicine, surgery, or obstetrics and gynaecology the layout is already in existence with the facilities provided in the basic subjects at the Royal College of Surgeons, together with the clinical material and teaching at the Post-graduate Medical School, and the specialist hospitals and institutes. The liaison between them, however, must become much closer than it is at present. The post-graduate teaching centre should not cater for any particular post-graduate examination, that is not its function. Facilities already exist at the various medical schools and institutes. The post-graduate centre should fulfil its true function of disseminating in a general way the knowledge already attained, and organize further endeavours to extend that range by appropriate research at properly selected centres.

It is to be hoped that a British Academy of Medicine will be erected on the Lincoln's Inn site so that post-graduate teaching for the whole country can be co-ordinated from a proper central authority. To quote from the Goodenough Report —

"For the avoidance of chaotic development, it is to be hoped that the Universities, in consultation with the professional and scientific bodies concerned will agree on a national plan for these Institutes and relate their individual schemes to this plan" (Goodenough Report, p 217)

A post-graduate hospital should be complete in all departments with a staff sufficient in knowledge and number, so that no patient whatever the disease should have to be sent elsewhere

The specialist trainee would then be able to realize the relationship of his specialty to general medicine and surgery before passing on to one of the 'special' hospitals or institutions as a 'finishing' school. A sufficient number of post-graduate centres and institutions will be required. Until such time as they are available, the District General Hospital could be used for 'resident' experience provided the staff is adequate in number and teaching experience.

This was fully recognized by the Goodenough Committee who reported concerning post-graduate education

"Many of its medical institutions have a world-wide reputation, yet London has failed to attract as many post-graduate medical students, even from the British Commonwealth, as have centres on the Continent of Europe or in the United States of America. The main cause, as Sir William Osler pointed out as long ago as 1911, has been lack of organization and cohesion. We recommend that when the present war is over these efforts should be pursued with increased vigour and determination."

The report found that the obvious nucleus of a scheme for the post-graduate medical education in London was the British Post-graduate Medical School.

Lord Addison, when Minister of Health, initiated the first steps which led to the foundation of the Post-graduate Medical College. In 1921 a Committee was set up under the Chairmanship of Lord Athlone to prepare various schemes, which later were examined and reported upon by another Committee over which Mr Neville Chamberlain presided. The constitution and organization of the college was completed by another Committee, of which Lord Chelmsford was the Chairman, and included representatives of the University of London, the Royal Medical Colleges, the Medical Research Council, the Ministry of Health, and the London County Council.

"The aim was to provide such a centre for the advancement of medical knowledge as would be worthy of the British Commonwealth and Empire", and under the Charter the administration had "to arrange for co-ordination with other authorities at present providing post-graduate or other medical or scientific education in London."

Owing to the war the school has not developed organized departments in the various special subjects and only recently has begun to establish links with the large special hospitals in London on the lines proposed by the Athlone Committee.

It is recognized that this may be due to two main causes, the geographical isolation of the Hammsmith Hospital on the one hand, and on the other by the fear that special hospitals might lose their identity and freedom of development by such a liaison.

The Goodenough Report gives a series of suggestions (pp 226-31) whereby the post-graduate teaching for London can be developed. They

should be carefully studied by all, as the principles apply to the whole country.

Since the report was written the development of teaching, lectures, and demonstrations organized by the Royal College of Surgeons has been very great and will be expanded still further. The establishment of a British Academy of Medicine would provide the central authority which should organize



Professor G. GREY TURNER

and mould the post-graduate teaching throughout the country. It should also be the body to provide the hallmark for *entrance* into medicine, just as other authorities do, in other professions, e.g., The Inns of Court, Institute of British Architects, etc.

The Minister of Health is taking steps in accordance with the recommendations in Chapter XIX of the Goodenough Report to organize the post-graduate medical education in London, by the formation of a British Post-graduate Medical Federation. A petition for a Royal Charter of Incorporation for the Governing Body of such a Federation will be presented shortly.

"The British Post-graduate Medical School incorporated by Royal Charter in 1931 is an Independent body recognized as a Medical School by the University of London."

It was opened in 1935. The main work of the Department of Surgery is arranged around the

clinical opportunities provided by the Hammersmith Hospital and the Professor has always aimed at establishing continuity in the teaching, which he endeavoured to maintain from the appearance of the patient in the out-patient department, through the wards and operating theatres, to the follow-up clinic. The students do not actually assist with or do operations.

It was a happy choice when Professor G. Grey Turner was invited to be the first occupant of the Professorial Chair of Surgery in the school and to



FIG 515 —Professor Grey Turner in his study

direct the Department of Surgery. He came to the school with a great record as a man, a surgeon, and research worker, from his own medical school at Newcastle-upon-Tyne, where at the time of his appointment he was Professor of Surgery in the University of Durham and Senior Honorary Surgeon to the Royal Victoria Infirmary.

The appended list of his publications bear witness to his capacity for work during a surgical career of forty-eight years. This list shows only one aspect of his busy life. In the background there are hundreds of medical students, many now getting on in years, who have benefited by his teaching and example both as undergraduates and post-graduates. In addition, throughout this country, the Dominions, and Dependencies of the Crown, and in other countries in Europe, America, and elsewhere there are many surgeons who have been fortunate enough to

have been his resident house surgeons or clinical assistants or registrars.

Others have profited by discussing their difficulties with him, reading his contributions to the surgical literature of the world, and by his succinct remarks at discussions during various surgical conferences all over the globe.

Those who served with him during the war of 1914-18 will bear witness to the stimulating effect he had on them by his teaching and endeavours, especially during the anxious periods of "waiting for something to happen" which is so trying to the military surgeon.

He gave of his very best in assisting at the foundation of the BRITISH JOURNAL OF SURGERY, the Association of Surgeons of Great Britain and Ireland, and the International Society of Surgery. He has not only maintained but enhanced the traditions of all. He has been a member of the Council of the Royal College of Surgeons for twenty years. He was one of the Hunterian Professors in 1928, delivered the Bradshaw Lecture in 1935, and the Hunterian Oration in 1945. The Professor throughout his career has been a surgical pilgrim and has visited most of the important clinics throughout the world. One of the great griefs of his life has been the destruction of part of the College and especially the museum and many specimens to which he has devoted so much of his time, by enemy action on May 10, 1941. His Hunterian Oration on "The Hunterian Museum Yesterday and To-morrow" reflected his feelings. It is now published and will be a worthy and standard record for many years to come of the foundation and development of that famous museum in the tradition of John Hunter.

The Department of Surgery has 175 beds, under the direction of the Professor. His staff consists of a Chief Assistant and five First Assistants. These are qualified and trained surgeons, each devoting himself to some special branch of surgery, in addition to general surgery. In other words, they can be described as general surgeons each with a surgical hobby.

In this way they are experts in the department, trained, qualified, and able to deal with the surgery of genito-urinary, thoracic, plastic, neurosurgical, orthopaedic, and traumatic cases. No particular branch of surgery is cultivated to the exclusion of others.

The professor is thus able to keep in touch with all these clinics, at the same time following his own particular inclination, which in the case of Professor Grey Turner is abdominal surgery, but not to the exclusion of general surgery, as for many years he has been interested in transplantation of the ureters, the surgery of the oesophagus, and the operative treatment of malignant disease in all its forms.

In normal times it is planned to have twelve house surgeons appointed for six months in a junior post, and six months in a senior one. The appointments will be staggered to procure continuity of service.

The layout of the department is such that wards, theatres, teaching museum, laboratories, and lecture rooms are in close proximity. In this way illustrative specimens can be easily procured for the discussions in the wards or theatres, or a lantern-slide

demonstration can be staged bearing on the work in progress, whether in the ward or theatre

There is the closest possible liaison between the Otorhinolaryngological and Ophthalmic Departments with that of the surgeon, and needless to say the expert pathologists, biochemists, and radiologists are always available

A time-table is published each week detailing the various activities proposed for the department. They consist of ward rounds, surgical discussions, operations, and out-patient clinics for general and special cases. There are demonstrations in surgical anatomy and radiology each week and smaller classes in the special branches are always in progress. There is no need for any student to find he has time on his hands, as there is a well-equipped library and school museum, and he can get food at 'the mess' on the premises.

Each week there is a clinico-pathological demonstration, at which the work of the previous weeks is reviewed, discussed, and correlated with the pathological findings. The specimens, both operative and from autopsy, are available, with pathological experts to discuss and demonstrate them. Everyone is encouraged to take part. From time to time acknowledged experts in some particular branch of surgery are invited to give lectures, and these are all well attended by students working in the different departments.

The students are actually allotted cases in the wards and they present these cases at the ward clinics. The Professor and his assistants give lectures on their own specialty. Clinical talks after the principal ward round are considered most useful and instructive. They are held in a demonstration room near the wards and in close proximity to the museum, and last about one hour.

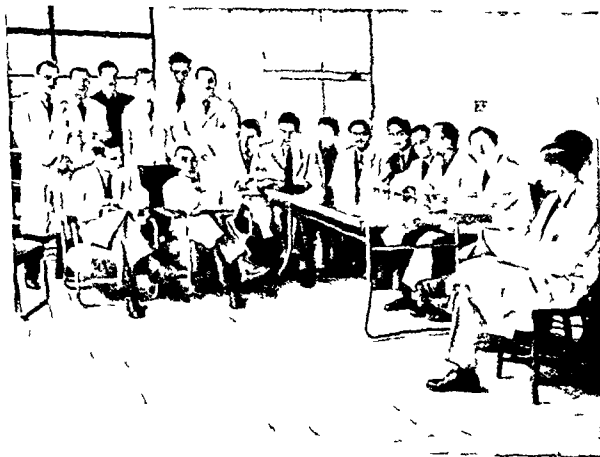


FIG 516 —The weekly clinico-pathological demonstration

During the war, at the request of the Deans of the respective medical schools in London, educational facilities were provided for undergraduates, and at the same time the London County Council provided residential accommodation for a number of them.

A new type of post-graduate student was also accepted, namely, refugees from Nazi oppression.

Intensive "war courses" were also arranged, acknowledged experts giving the lectures and practical demonstrations. The subjects were various, including war surgery of the abdomen, the extremities, the chest, the nervous system, and the miscellaneous aspects of war surgery. There was also an intensive course lasting a week on some one particular subject.

The school was opened in 1935, and, naturally, the peak year for numbers was 1938-9, the students



FIG 517 —An operation in progress

being two or even three times more numerous in some departments than in 1935. Even during the war period the school was never without students and often from overseas and war areas.

As the war progressed the number of post-graduates diminished. In 1940-41, the last year for which figures were published, 397 students attended from Great Britain and Northern Ireland, 116 from the Dominions, Crown Colonies, and Dependencies, 27 from other countries. In addition there were always visitors from the Allied armies, and from occupied countries.

A typical day's work recently witnessed in the surgical department was as follows —

It was an operating morning and the Professor explained that every such occasion was only useful if the visitor knew the circumstances of each case and what it was proposed to do. Each important step could then be followed. When students were few they were allowed to come quite close up to the table but on account of the numbers a stand was now used which could be moved so that for each case the most favourable position could be chosen. Further, students deemed most likely to profit were often invited to come down to the Professor's elbow in order that some step might be the more accurately demonstrated.

#### *Operations —*

#### **1 Cholecystectomy for Cholecystitis and Gall-stones in, a Woman aged 80 years**

She had had three severe attacks of pain accompanied by transient jaundice since Easter, 1946, and wished for relief.

Before the operation the history and possible differential diagnosis of the case was discussed,

although the case had been previously demonstrated on a ward round. The bearing of the age of the patient on the problem was discussed.

The lower thorax of the patient, after she had been anaesthetized, was raised by insertion of the double wooden wedge which is so dear to the heart of the Professor, and the arms were extended on a board at right angles from the trunk to prevent any pressure neuritis.

The students were reminded that it was Mayo Robson, of Leeds, who first demonstrated the value of the elevated loin position.

Kocher's incision was used. There were no stones in the common duct and no lesion of the pancreas, so cholecystectomy was done.

During this operation, and the two subsequent ones, the Professor kept up a running commentary, which, if duly noted and memorized, was alone worth much to the onlookers.

"When the gall-bladder enlarges it is usually in the direction of the umbilicus."

"A line from the left anterior superior iliac spine continued through the umbilicus to the right costal margin gives the position of the fundus of the gall-bladder."

"A gall-bladder swelling becomes more defined as the surrounding inflammation subsides, this is a point to be remembered."

"Kocher—dear old Kocher of Berne—always insisted that this incision disturbed the peritoneal cavity less than any other. I am sure that he was right, and this compensates for its limitations."

"No 'catch it again' all hæmorrhage must be stopped and prevented. Extravasated blood is dying and dead tissue is an excellent nidus for organisms!"

"A history and diagnosis of cholecystitis may be the result of early malignant disease of the gall-bladder and that condition is rarely cured by surgery."

"In Great Britain cholecystitis usually means gall-stones, but not by any manner of means is that the case in the Middle and Far East."

"The gall-bladder and its surroundings must be explored slowly and gently, otherwise a fistula into the alimentary canal may be precipitated."

"The way to avoid accidents to the common duct is to dissect so that it is clearly seen, together with the junction to the cystic duct."

"Always ligate and divide the cystic artery before the cystic duct, as the latter can be used for gentle retraction, whereas the most gentle pull on the artery would tear it."

Between the Professor and his assistant, however, there was the silence of perfect understanding.

After the operation the professor closed the wound while the assistant demonstrated the specimen to the onlookers. The professor insisted on the importance of such examination while the abdomen was still open. Even in the most careful hands he had seen a piece cut out of the common duct.

## 2 Transplantation of the Ureters into the Colon

This was a preliminary operation before dealing with an extensive malignant growth of the urethra which had extended up into the bladder in a big, stout woman of 63 years. Later it was proposed

to do a total excision of the bladder and urethra (This was successfully carried out a few weeks later).

The same type of running commentary was kept up. The operation is one which Professor Grey Turner has made peculiarly his own and has described so many times in various papers and discussion. He recently gave a demonstration of many of his early cases before the British Association of Urological Surgeons. He mentioned to the onlookers the first case in which he had transplanted the ureters 34 years ago. Twenty-three years after transplantation he removed a calculus from one of the ureters. This patient is still alive and well, she is the mother of three children and now has two grandchildren. The Professor went on to describe several other cases, contrasting the misery of the incontinent with the contentment after successful transplantation. He also drew attention to the widening field of usefulness for the operation.

He demonstrated every step, mentioning how he differed in small details from the methods of Stiles, Coffey, Henry Wade, and others, and why he considered the technique he now employed gave the best results.

The technique and care exercised were beyond criticism.

Afterwards the details were again discussed with the aid of large diagrams brought into the theatre.

The students then accompanied him into a small lecture room next to the Museum and opposite the Theatre. He gave them half an hour's talk on the surgery of malignant disease, illustrated by specimens, and lantern slides showing Sir Henry Butlin, George Crile, William Stewart Halsted, and others. He considers that the history of surgery should go hand-in-hand with consideration of the art. He showed them the statistical results of operation for cancer of the breast published by Sir Gordon Gordon-Taylor in the *British Medical Journal*, Nov. 26, 1938, which he stated were probably as good as any surgery has ever attained.

A short ward round was then made to see some of the cases recently operated upon. The after-treatment was discussed in a few and reasons for the various methods adopted.

## 3 Removal of Malignant Glands of the Neck following Epithelioma of the Ear in a man aged 71

The method of Crile was employed. Reasons for the surgical removal of lymphatic glands in certain cases rather than relying on radiotherapy were given, and it was pointed out that it was Henry Butlin, of Bart's, who enunciated the principles on which Crile's method was based.

The operation progressed all the time he was making his remarks. It was done with scrupulous care as only a master of his art could command, and yet all went so smoothly that it simulated the abandon of an accomplished ballerina. The problems, beyond the technical details of the operation, were indicated and discussed as subjects full of interest and importance.

The Professor stressed the point that useful research was always that which arose directly out of clinical work. The accomplishment of his medical colleagues along these lines was mentioned with enthusiasm.



The whole day was an exhibition of a master sure of himself and yet careful in every detail, no better illustration could have been given of the Hippocratic precept —

"Wherever the art of medicine is loved, there also is love of humanity"

Professor Grey Turner's personality, which has influenced those who have worked with him so much, cannot be better described than in the words used by Kipling with reference to such another —

"Clean, simple, valiant, well beloved,  
Flawless in faith and flame,  
Whom neither ease nor honours moved  
An hair's-breadth from his aim"

His work at the Post-graduate School has initiated a tradition which is of such a standard that those who follow him will do well to maintain

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## THE PARASYMPATHETIC SUPPLY OF THE DISTAL COLON

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A PARASYMPATHETIC supply arising from the sacral nerves to the distal colon has long been the subject of controversy. Such a supply had been assumed on physiological grounds, although there was no topographical evidence until Telford and Stopford, in 1934, described the anatomical distribution of the parasympathetic fibres. While there is general agreement as to the origin and distribution of the sympathetic supply, there is no exact knowledge regarding the parasympathetic innervation, and it is necessary to establish first that there is such a supply and precisely how it reaches the bowel.

The general pattern of the nerve-supply of the alimentary canal consists of extrinsic nerves, such as the vagus, entering the bowel wall and coming into intimate synaptic connexion with the intrinsic cells of the colonic plexuses (Auerbach's and Meissner's). These colonic plexuses consist of an interlacing of fine fibres and ganglia throughout the whole bowel. Stimulation of any one part of these plexuses will thus spread in a wave-like movement up and down the length of the bowel.

Dogiel (1896), as quoted by Babkin (1944), was the first to establish that there are two main types of ganglion cells, Type I and Type II, in the enteric plexuses. The relative numbers of cells of each type vary in the gastro-intestinal tract of the dog. By cutting the vagus and pelvic autonomic and allowing them to degenerate, Lawrentjew (1926), quoted by Babkin (1944), established that the cells of Type I in the proximal and middle portions of the gastro-intestinal canal are in synaptic connexion with the vagus and those in the hinder part of the canal with the pelvic autonomic. In the rectum, again, the extrinsic nerve-fibres derived from the pelvic autonomic are more numerous. Where the parasympathetic fibres predominate there is a correspondingly greater number of Type I cells.

Schmidt (1932), in a series of histological investigations in which the vagus was sectioned just below

the diaphragm, found degenerated fibres in the ascending and transverse colon. They were less numerous in the latter than in the former, while no evidence of nerve degeneration was found in the distal colon. Division of the sacral nerves showed degeneration of nerve-fibres throughout the whole of the large gut, this degeneration predominated in the hind-gut area.

If, therefore, a parasympathetic supply to the whole of the large bowel exists, its distribution should be established. From a survey of existing anatomical and physiological literature two alternative possibilities were considered—

- 1 That the distal distribution of the cranial parasympathetic extends as far as the lower limit of the colon and that the sole contribution of the sacral parasympathetic is to the rectum.

- 2 That the areas of vagus and sacral parasympathetic join or overlap at some position which would correspond to the morphological meeting of hind- and mid-gut. In other words, that the innervation of the entire hind-gut is from the sacral parasympathetic.

From the point of view of surgery of the distal colon and pelvic viscera, it is essential to establish which of these two hypotheses is correct—namely, the distal colonic extent of the vagus and the proximal extent of the sacral parasympathetic.

A junction in the parasympathetic innervation of the large bowel was first suggested by Cannon (1902) when he found a ring of contraction dividing the colon into two portions. Arendt (1945), in a radiological study, was unable to find any anatomical sphincter in this neighbourhood, but from his radiological observations he suggested that this contraction ring was a pivoting point in a change of colonic innervation between the cranial and pelvic parasympathetics. The situation of this point was variable in the transverse colon, but had a tendency to be in the right third. "An antagonism between

the two spheres of influence must occur, either the distal part has to be wide and relaxed and the proximal part contracted, or the reverse must be the case. The phenomenon of the contraction ring permits an explanation of a critical reaction at the point of overlapping of nerve impulses." Arendt suggested that this point be called the Cannon-Boehm point in honour of these earlier observers.\*

It was assumed for a long time that the vagus was the sole parasympathetic supply to the colon, indeed, the lower region of the rectum, which obtained its innervation from the *nervi erigentes*, was the only part of the gut excluded from this vagal influence. Jayle and Cabanac (1932) have actually described vagal fibres to the distal colon, but this is not generally accepted. Luke Mitchell (1935), we also found it impossible to dissect vagal fibres extending to the distal colon owing to the marked complexity in this area.

Woollard (1935) was inclined to follow the French anatomists who extend the vagus anatomically as far as the limits of the colon and confine the pelvic nerve to the pelvis. However, in his illustration there is a suggestion that there is a supply to the colon coming upwards out of the pelvis from the sacral autonomic. Savich and Soshestvensky (1917) demonstrated that stimulation of the vagus in the cat, in which the spinal cord had been cut below the medulla, was only effective as far as the ileocaecal valve.

McCrea (1924), in an investigation of the abdominal distribution of the vagus, showed that the anterior vagal plexus supplied twigs to the pyloric antrum on both anterior and posterior surfaces. In no case did it send fibres as far as the pyloric canal or sphincter. Fibres were also given off this plexus to the coeliac plexus. The posterior vagal trunk supplied fibres to both right and left coeliac ganglia, while other fibres anastomosed with the sympathetic fibres and ran with the superior mesenteric artery. He stated that "it is a matter of considerable difficulty to determine whether these last fibres are vagal or sympathetic or both, on account of their intricacy and the manner in which the nerves are matted together." These findings of McCrea were confirmed by Brandt (1920), and it appeared that the majority of vagal fibres were destined for the stomach and that very few fibres carried on to the coeliac plexus.

It would thus appear that the vagus is limited to some point in the transverse colon at the most. We therefore tried to find anatomical evidence of a pelvic parasympathetic innervation extending upwards as far proximal as this point.

### PREVIOUS ANATOMICAL OBSERVATIONS

Telford and Stopford (1934) described on the ventral side of the inferior hypogastric plexus two small nerve-bundles which could be traced upwards. These bundles converged to meet and fuse at the

left side of the hypogastric plexus, and, passing upwards, crossed the left common iliac artery to join the inferior mesenteric artery one to one and a half inches distal to the origin of that artery from the aorta. The fibres from the single bundle were distributed with the branches of the inferior mesenteric artery. Where it crossed the left common iliac artery fibres were given off to run with the sigmoid and superior hæmorrhoidal vessels. These workers further claimed that, by careful dissection, they were able to follow the fibres downwards through the inferior hypogastric plexus and to demonstrate their continuity with the pelvic splanchnic nerves.

Mitchell (1935), in a careful investigation on 15 European infant bodies, found this arrangement in 4 out of the 15 bodies only, but in 10 others he found colonic nerves which he decided were probably important parasympathetic pathways to the colon. These colonic nerves arose from the inner borders of the hypogastric nerves and the upper part of the hypogastric plexus and passed direct to the sigmoid colon. There was no proof of the assumption that these were parasympathetic colonic fibres, because, as he states, it was "impossible in these small subjects to trace the course of these fibres in the inferior hypogastric plexus."

The description of Telford and Stopford entails important surgical implications and is widely accepted. But as Mitchell's observations differed so considerably from their description, the object of our dissections was to ascertain the anatomical distribution of the parasympathetic fibres to the distal colon in the South African Bantu.

### AUTHORS' INVESTIGATIONS

**Method and Materials.**—Nine infant bodies, including two seven-month foetal bodies, and nine adult bodies, all Bantu, were dissected. The following technique for the exposure of the parasympathetic supply to the distal colon was adopted.—

1 The anterolateral abdominal wall was completely removed.

2 The symphysis pubis was split longitudinally and forcibly opened.

3 In order to obtain a flat plane, so that the posterior aspect of the rectum and the anterior aspect of the sacrum could be approached with ease, the whole side wall of the pelvis was sawn off, leaving a small portion of the ilium attached at the sacro-iliac joints. Care was taken not to injure the pelvic colon or the soft tissues over which the inferior hypogastric nerves ran.

4 The bladder was removed in all bodies, the uterus and vagina were removed in female bodies and the prostate in adult male bodies. This technique facilitated approach to (a) the emergence of the sacral nerves, (b) the origin of the sacral parasympathetic, (c) the entire rectum.

**General Survey of Findings from Dissections.**—Variations occurred in practically every body and even between the right and left sides of the same body. Our results are best summarized, therefore, by giving a general survey of the origin, course, and distribution of these parasympathetic fibres.

1 *Left Side* (see Figs 518–520).—The interlacing pelvic autonomic plexus usually arises from the

\* On examination of 26 adult cadavers, we found that in 22 the descending colon was contracted, while the ascending and part of the transverse colon was dilated. In 6 of these 22 cadavers there was a definite contraction ring in the distal half of the transverse colon.

anterior aspect of second and third sacral nerves within a centimetre of the exit of these nerves from

passing upwards, run into the mesentery of the bowel. It is noteworthy, as Mitchell likewise found, that



FIG 518—Adult body. Origin, course, and distribution of pelvic parasympathetic colonic fibres from sacral nerves. The specimen is being viewed by an observer standing on the left side. The bowel has been displaced to the right, the pelvic wall on the left side has been removed. 1, Dense parietal pelvic fascia being pierced by some of these fibres. 2, Rectum. 3, Sacral somatic nerves giving rise to the nervi erigentes and parasympathetic nerves. 4, Superior hæmorrhoidal artery. The association of this artery and the parasympathetic fibres is seen. The uppermost fibre is at least 2 in. from the origin of the inferior mesenteric. The lowermost fibres would be absolutely safe in a perarterial strip of the inferior mesenteric. 5, Sacral sympathetic ganglion. 6, Left inferior hypogastric plexus, the lower end of which can be seen running into the parietal fascia.

In all illustrations the parasympathetic fibres have been painted over in white to differentiate them from the other structures.

the anterior sacral foramina. Well-defined fibres proceed anteriorly, and these are the classical nervi erigentes. In addition to these, moderately thick strands, usually from 3 to 6 in number, pass medially from the plexus, upwards and anteriorly, and could be traced to the distal colon.

A feature of each dissection is a striking rich whiteness of these parasympathetic colonic nerves, which is especially evident in the infant bodies. The fibres also give the impression of having minute undulations on their anterior surface, while on some of the fibres an extremely delicate blood-vessel may be seen. The appearance of a red vessel running on a creamy-white nerve is an excellent aid in tracing these nerves up and down, from the midst of the inferior hypogastric plexus. One of our main technical difficulties was to trace these fibres through the dense felted parietal layer of pelvic fascia, especially in the adult bodies, eight were discounted because of failure to trace the continuity of the fine nerves through this fascial layer.

Shortly after piercing the parietal layer of pelvic fascia fibres are given off to the rectum, while the remainder become closely associated with the superior hæmorrhoidal artery. The fibres on the left on their upward course show connections with the inferior hypogastric plexus. At about the level of the sacral promontory the fibres swing away from the artery across the left common iliac artery, and,



FIG 519—Infant body. Course and distribution of the left pelvic parasympathetic colonic fibres. The body is viewed by an observer standing on the left side and the rectum, pelvic colon and descending colon have been displaced to the right. The left side of the body is undermost in the photograph. The sacral nerves are not visible in this photograph, however the pelvic parasympathetic colonic fibres were found arising from them. 1, Pointer raising these fibres from the anterior aspect of the sacrum. The fibres nearest the tip of the pointer are in close proximity to the inferior hypogastric plexus which is lying deep to them. Connections between these can sometimes be seen. The fibres farther from the tip of the pointer can be seen accompanying the superior hæmorrhoidal artery. 2, (a) Rectum, (b) Pelvic colon, (c) Descending colon. 3, Ureter. 4, Inferior mesenteric artery at the point of origin of the left colic artery. Immediately above is seen one of the sigmoid arteries. The parasympathetic fibres can be seen crossing the vessels. 5, Superior hæmorrhoidal artery. 6, Left common iliac artery.



FIG 520—Infant body. Course and distribution of left colonic parasympathetic fibres. The body is lying on its back and is viewed from the front. The cut edges of the abdominal wall can be seen. The pelvic and descending colon have been displaced to the right. In this specimen the sacral origin of the fibres was not dissected. 1, Tip of the pointer lifting these fibres from the superior hæmorrhoidal artery. This close association with the superior hæmorrhoidal artery in the early part of their course is always a prominent feature. Consequently, in resection of the rectum, these fibres will necessarily be removed. 2, (a) Rectum, (b) Pelvic colon, (c) Descending colon, all of which have been displaced to right side to show the nerves running in the mesocolon.

these colonic fibres do not follow the arterial branches which are being distributed to the bowel wall, they cross them obliquely on the left (*Fig 521*) \*

nor can we find that these nerves, have the degree of compactness and close association with the inferior hypogastric plexus they claim. We find

Telford and Stopford's description applicable in only one out of eighteen dissections, and yet in this single instance fibres arose from the left pelvic splanchnics, which were quite unassociated with this artery. As already noted, in no cases did we find the colonic nerves being distributed with the arterial supply, nor was there any macroscopical connexion between the right and left sides, these being two main points in Telford and Stopford's description (*Fig 525*).

There is considerable similarity between the colonic fibres which Mitchell describes in the European and those we find in the Bantu, Mitchell also found that these nerves do not follow the course of any particular vessel. However, in contradistinction to Mitchell's observations, we do not find that these nerves arise from the sympathetic fibres, i.e., the hypogastric nerve and the inferior hypogastric plexus, but directly from the sacral nerves themselves. There are connexions

between these nerves arising from the sacral nerves and these plexuses, but in the Bantu, the pelvic

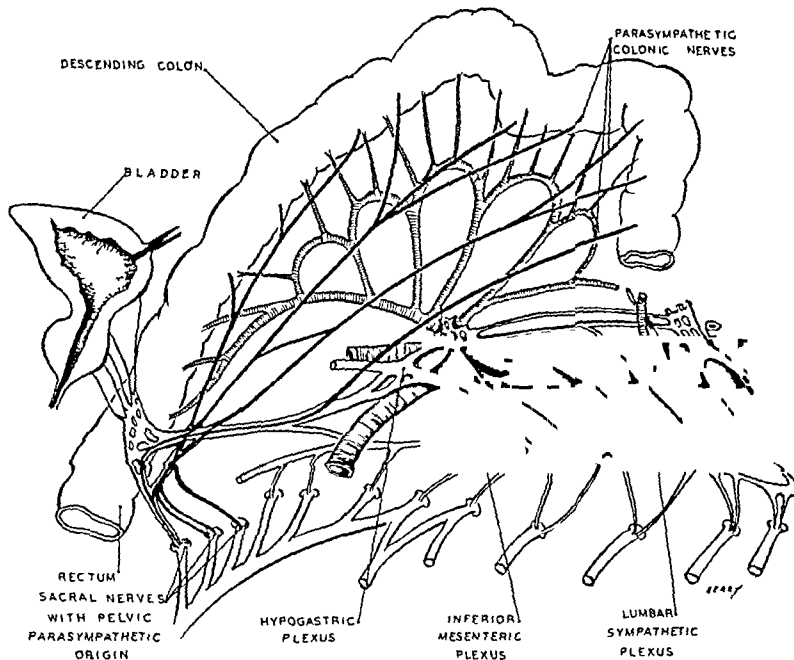


FIG 521.—Diagrammatic representation of the origin and distribution of the pelvic parasympathetic colonic nerves. The lower descending and pelvic colons have been swung over to the right. (Modified from Trumble.)

From the main upward stream fibres are given off at intervals, passing anteriorly, and have been traced definitely into the bowel wall. Macroscopically, the highest point to which these fibres are generally distributed is the middle of the descending colon, smaller fibres can, however, be seen to become associated with the ascending branches of the colic artery.

2 *Right Side (Figs 522-524)*—The general plan is similar to that of the left, but on the whole the nerves lie at a distance from the superior hæmorrhoidal artery and in closer association with the inferior hypogastric plexus. In one instance the colonic nerves run on the surface of the inferior hypogastric plexus and leave just below the bifurcation of the superior hypogastric plexus (presacral nerve) to become associated with the inferior mesenteric artery, at about the point indicated by Telford and Stopford, i.e., 1-1' in from the origin of the artery. The fibres which lie on the right side of the colonic mesentery in the majority of cases reach a higher level of the colon than those on the left. In addition, fibres are given off to the iliac vessels and to the ureter. There was no demonstrable connexion between the nerves of the right and left sides.

Reviewing the position, it will be seen that our findings contrast markedly with those of previous workers. We cannot establish the simplicity of arrangement described by Telford and Stopford,

\* In an undissected body these fibres would be lying against the posterior abdominal wall, being separated from it by the left layer of parietal pelvic mesocolon, the resection of which will clearly expose these nerves.



FIG 522.—Infant body right side of *Fig 519*. Origin, course, and distribution of the right pelvic parasympathetic colonic fibres. The body is viewed by an observer standing on the right side. The bowel has been displaced to the left, which is in the uppermost part of the picture, i.e., the body is lying on its right side. 1 Point of origin of right parasympathetic fibres from sacral nerves. The fibres can be seen passing to the left and do not have in the early part of their course such close association with the superior hæmorrhoidal artery as on the left side. 2, (a) Rectum, (b) Descending colon, which has been swung over to the right, (c) Sigmoid colon. 3, Right common iliac artery. 4, Inferior mesenteric artery. The fibres are quite unassociated with this artery, and stripping of this structure would not affect them. 5 Inferior hypogastric plexus. The lower pelvic parasympathetic colonic fibres can be seen crossing this structure. 6, Sacral sympathetic ganglion.

parasympathetic and sympathetic exist as distinct entities. This seeming anatomical discrepancy between the European and the Bantu may be due merely to the

This work of Denny-Brown and Robertson has the support of the comparative physiological evidence of Wright, Florey, and Jennings (1938), who found



FIG 523—Adult body. Origin, course, and distribution of right pelvic parasympathetic colonic fibres. The body is being viewed by an observer standing on the right side. The left side is above in the photograph, to which side the bowel is displaced. 1, Sacral nerves with colonic parasympathetic fibres and the *nervi erigentes* arising from them. 2, (a) Rectum, (b) Pelvic colon, (c) Descending colon, which has been swung over to the right. 3, Inferior hypogastric plexus running downwards. On the surface of the structure can be seen the parasympathetic fibres. These fibres are individual, having no degree of compactness. 4, Inferior mesenteric artery. Above this artery, i.e., to the left, the parasympathetic fibres can be seen running in the mesocolon crossing the blood vessels.



FIG 524—Infant body. Origin, course and distribution of the right pelvic parasympathetic colonic fibres. The body is being viewed by an observer standing on the right side. The left side is at the top of the photograph, to which side the bowel is displaced. 1, Tip of pointer lifting these fibres off a part of the inferior hypogastric plexus which is descending into the pelvis. Connection between this plexus and the pelvic parasympathetic fibres can be seen at this point. 2, (a) Rectum, (b) Pelvic colon, (c) Descending colon. 3, Origin of the pelvic parasympathetic colonic fibres from the sacral nerves. 4, Reflected anterior abdominal wall. 5, Right common iliac artery. Immediately below is seen a sacral sympathetic ganglion. 6, Inferior hypogastric plexus. 7, The ureter is displaced to the right. 8, Inferior mesenteric artery.

different dissecting techniques adopted by ourselves and Mitchell. We obtained direct access to the anterior aspect of the sacrum and commenced the dissection from the point of origin of these fibres.

### DISCUSSION

In the Bantu there is gross anatomical evidence that nerve-fibres arise from the second and third sacral nerves and are distributed directly to the descending colon and rectum. These nerves send communicating branches to the hypogastric plexus but do not in general follow the arterial distribution. To these independent fibres we ascribe a parasympathetic function because of their sacral origin. In support of this thesis there is radiological, physiological, and clinical evidence.

Arendt's radiological evidence of a Cannon-Boehm point, which has been dealt with earlier, is in agreement with our ideas, as are Denny-Brown and Robertson's clinical observations (1935). These investigations concluded that the mechanism which controls the evacuation of the bowel is mediated entirely through the lower parasympathetic sacral segments of the spinal cord and its peripheral plexuses. There is no evidence that the sympathetic system plays any part. From a colon-metrogram study of the change in bowel activity after lesions of the nervous system at various levels, it is clear that reflex activity and ability to empty the colon effectively persist until the reflex centre in the spinal cord, *corda equina*, or the pelvic nerves has been injured. After sympathetic denervation of the rectum and colon there was no alteration in peristalsis.

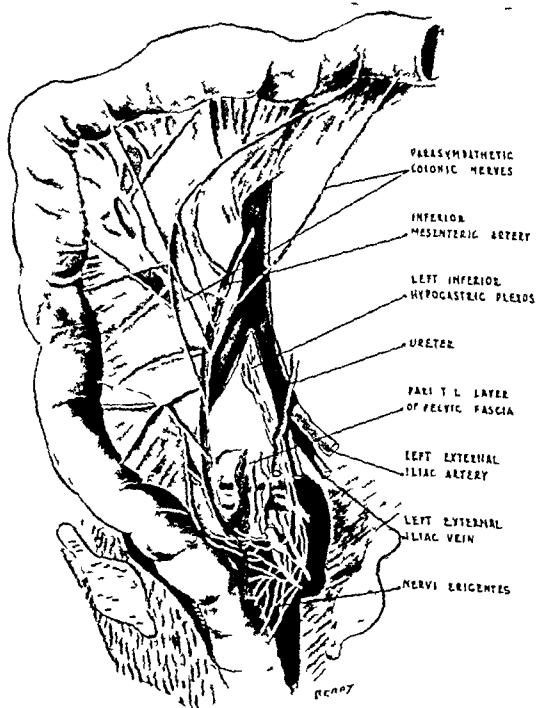


FIG 525—A schematic representation of the pelvic parasympathetic colonic nerves showing how they traverse the parietal pelvic fascia and their distribution in the mesocolon. The lower descending and pelvic colons have been swung over to the right.

that stimulation of the colonic sympathetic nerves caused relaxation of the colon, contraction of the blood-vessels, and did not excite any secretion of fluid. Stimulation of the nervi erigentes, on the other hand, caused contraction of the bowel with secretion and vasodilatation. To prove the distribution of the pelvic autonomic nerves to the descending colon they placed a ligature tied tightly round the colon and no matter whether it was placed high up or low down, the site of this ligature determined the upper limit of secretion and contraction following stimulation of the nervi erigentes. Even when scrupulous care was taken to avoid including any mesenteric structures in the ligature, this was the case. In three cats, where the string was tied loosely so that the tunica muscularis was not crushed, the effect of stimulation extended above the ligature as far as the lower three inches of ileum. Stimulation of the sympathetic nerves showed no such delimitation by the ligature, but extended as far as the vessels with which they were associated. This shows that the sacral parasympathetic fibres are not distributed with the vessels or with the sympathetic nerves, but enter the gut in the pelvic part of the colon and the upward distribution of stimuli transmitted through them takes place in the bowel wall.

Lawrentjew (1926), quoted by Babkin (1944), states that each parasympathetic fibre on entering the bowel wall, branches out and synapses with a great number of ganglion cells in the colonic enteric plexuses. Thus he calls a "multiplication phenomenon". If this is so, then only a few parasympathetic fibres would be required to transmit impulses to the whole of the lower colon through the colonic plexuses, since, as already established by the presence of Type I cells, they are in synaptic connexion throughout the bowel. This is in keeping with our dissection findings, where we have three to six basic fibres from either side, constituting the whole parasympathetic supply to the lower colon. Again Adamson and Aird (1912) found constantly that by division of the pelvic parasympathetic of cats there was definite radiological evidence of dilatation of the colon after six weeks and gross dilatation at the end of fifteen weeks.

If our interpretation is correct, then some of the problems associated with colonic and pelvic surgery become clarified—

1 In periarterial stripping of the inferior mesenteric artery, which Telford and Stopford advocate for the treatment of megacolon, they lay stress on the fact that damage may be done to the parasympathetic supply to the colon if this stripping is carried farther than the proximal 1½ in of the artery. Since, however, we have shown that the colonic parasympathetic supply is fundamentally dissociated from this artery, we feel there can be no parasympathetic dysfunction caused in this operation, no matter how far the artery is stripped.

2 Resection of the rectum and lower pelvic colon involves interruption of these pelvic parasympathetic nerves, since on the left side the fibres are closely associated with the left superior hæmorrhoidal artery, on the right side some of the right parasympathetic sacral fibres will be divided, since they run in the pelvic mesocolon, part of which is removed in a resection of the pelvic colon.

3 High resections of the colon, i.e., proximal to the point of entry of the highest parasympathetic colonic fibre (which on the average is situated at the mid-point of the descending colon), involve a break in continuity of the colonic plexuses at the point of resection. Parasympathetic impulses will, therefore, be prevented from reaching the gut proximal to the resection. Theoretically, this deprivation of parasympathetic stimuli to the proximal colon should result in functional disturbance, whether this obtains clinically has not as yet been demonstrated.

4 Again, in presacral neurectomy, if the findings of Telford and Stopford are correct, there should be fundamental dysfunction of the parasympathetic supply of the rectum and lower colon. There is no reason to suppose that in such fundamental anatomy as this, there would be any comparative racial differences between European and Bantu, and we have shown that the colonic parasympathetic supply does not have the close association with the hypogastric plexuses. Telford and Stopford suggest. Thus, even if the presacral nerve and the upper parts of the right and left inferior hypogastric plexus were removed, there would be no vital damage done to the parasympathetic functions of the rectum and lower colon.

## CONCLUSIONS

1 The parasympathetic innervation of the distal half of the large bowel is derived from the sacral division of the parasympathetic system.

2 The nerves enter the distal colon independently of the blood-vessels and end in association with the intramural colonic nerve-plexuses.

3 Periarterial stripping of the inferior mesenteric artery and presacral neurectomy should not interfere with the parasympathetic function of any part of the colon.

4 In resection of the rectum and pelvic colon, the parasympathetic supply to the colon will be destroyed.

5 In high resection of the colon, that portion of the colon between the point of resection and the distal point of vagal parasympathetic supply, will be deprived of its parasympathetic supply.

We wish to express our thanks to Professor Raymond A. Dart for allowing us facilities in the Department of Anatomy, and to Mr A. Lee McGregor for suggesting this investigation.

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# A STATISTICAL STUDY OF 1405 CASES OF CANCER OF THE STOMACH

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In its Twenty-first Annual Report, the British Empire Cancer Campaign (1944) published a statistical survey of 1405 cases of primary cancer of the stomach compiled by the Clinical Cancer Research Committee. This report was based on the replies to a special questionnaire which was issued to all the voluntary and municipal hospitals in the Administrative County of London, with the exception of a few special hospitals, and was filled in by the Registrars between April 1, 1938, and Sept 3, 1939. At the time of publication of the report only a four-year follow-up was possible, now that the whole series has been followed up for five years, with only 1 per cent of the patients untraced, an analysis of the main findings, particularly as regards factors governing operability and survival rate, may be of interest and value to surgeons.

There were 856 males (11.7 per cent of all male cases of cancer registered), and 549 females (6.9 per cent of all female cases), so that the sex ratio is  $60.9 \pm 1.3$  per cent of males, or roughly three males to two females. The region of the stomach affected was known in 871 cases by operation or post-mortem findings and the sex ratios in these cases are shown in Table I.

Table I—SITE OF GROWTH

SITE OF GROWTH	NUMBER IN SITE	PERCENTAGE	PERCENTAGE OF MALES
Pyloric region	470	54.0	$62.1 \pm 2.2$
Mid-gastric or whole stomach	287	33.0	$64.1 \pm 2.8$
Cardiac region	114	13.0	$64.9 \pm 4.5$
	871	100.0	

The differences in the percentage of males in the different regions are not statistically significant.

**Age Distribution (Table II)**—The youngest cases were a female aged 20 and a male aged 21,

Table II—AGE DISTRIBUTION

AGE GROUP	MALES	FEMALES	TOTAL
15-24	1	2	3
25-34	8	16	24
35-39	27	21	48
40-44	45	16	61
45-49	60	38	98
50-54	117	55	172
55-59	138	78	216
60-64	167	113	280
65-69	143	89	232
70-74	94	72	166
75-79	44	39	83
80 and over	12	10	22

Mean age Standard deviation  
 Males  $60.06 \pm 0.36$   
 Females  $60.67 \pm 0.51$   
 Difference of the means  $0.61 \pm 0.62$

both proved microscopically, and a female aged 23, whose subsequent clinical course proved that the condition was malignant, though there was no microscopical examination.

The mean age of the 691 patients who were submitted to operation was 56.83 years. The relationship between age, operability, and results will be examined later.

**Aetiology**—The occupations of 856 male patients were arranged in order of frequency and compared with the percentage of males over 14 years of age in Greater London following the same occupations, as recorded in the 1931 Census. The figures corresponded closely enough to warrant the conclusion that the hospital admissions were a fair sample of the occupied population of Greater London. The figure for clerks and typists was significantly lower than expected, but this may be accounted for by the fact that many were shown in the 'retired' group, the previous occupation not being given. The Registrar-General (1938) states that there is no statistical evidence of any connexion between mortality from gastric cancer and the effects of occupation. Investigations into the habits of patients in regard to consumption of alcohol, hasty eating, hot or highly spiced food did not yield any statistically significant results, as the percentage of cases in which the question was not answered was too high and no control figures for the general population were available. Oral sepsis was present in 26 per cent of the patients, the percentage of males being nearly twice that of females. Herbert and Bruske (1936) found that gross oral sepsis was present in 28 per cent of 500 unselected hospital patients, aged 30-60, with the sexes in equal numbers, figures which may be used as a control. 19.6 per cent of the patients gave a history of previous long-continued dyspepsia, in 13.2 per cent of whom there had been a variable period of freedom from symptoms prior to the onset of the present illness and in 6.5 per cent the symptoms had been continuous. Payne (1940) found that in about 20 per cent of 506 cases seen at St Bartholomew's Hospital the length of history exceeded two years.

**First Symptom**—Definite pain after food was the first symptom in 24.7 per cent of all patients and vague dyspeptic symptoms in about 18-22 per cent, whatever the situation of the growth. Those in the pyloric region commenced with pain not definitely related to food in 24 per cent and with vomiting in 14.7 per cent. An insidious onset with asthenia and anorexia was most common (18 per cent) in growths of the mid-gastric region, whilst dysphagia and regurgitation of food were common initial symptoms (26 per cent) of those in the cardiac region. Sudden onset with hæmatemesis occurred in 1.5 per cent and was most frequent in growths of the cardiac region (3.5 per cent). In 0.6 per cent of patients



there were no symptoms directly referable to the stomach and the diagnosis was first made at operation or at post-mortem examination. In 13 per cent of patients the discovery of metastases in bones, lungs, or lymph-nodes preceded that of the primary. The onset of symptoms was stated to have been sudden in 22.8 per cent and gradual in 68.4 per cent.

**Delay in Seeking Medical Advice**—54.5 per cent of all patients consulted a doctor within the first three months, another 10 per cent within the next three months, leaving 35.5 per cent in whom the disease was presumably of over six months' duration when first seen, but in 22 per cent the exact interval was not stated.

**Delay in Sending to Hospital**—16 per cent of the patients came direct to hospital, 37 per cent were referred to hospital for investigation at once and 13 per cent after an interval of less than three months, but 19 per cent were treated symptomatically for more than three months and 1 per cent were told that there was nothing to worry about. In 13.8 per cent the question was not answered. The figures for the 691 operated cases showed no significant differences from the above percentages.

#### Findings on Examination—

**Weight Loss**—17.5 per cent of the patients had lost up to 2 st in weight since the onset of symptoms, 19.4 per cent more than 2 st, whilst in 52.5 per cent the exact amount was not known. In only 3.8 per cent had there been no loss of weight.

**Palpable Tumour**—There was a definite palpable tumour in 49 per cent of the patients and an indefinite mass in a further 9 per cent.

**Clinical Signs of Dilated Stomach**—Obstruction to the passage of food was diagnosed clinically in 33.6 per cent of growths in the pyloric region, 10 per cent of mid-gastric growths, and 7.0 per cent of those at the cardia. An X-ray examination after an opaque meal was carried out in 68.5 per cent of all patients. The findings are shown in Table III, by regions affected.

Table III—X-RAY FINDINGS  
(Percentages)\*

	PYLORUS	MID-GASTRIC	CARDIA	REGION NOT STATED
Total number of patients examined	335	187	86	355
Filling defect	68.5	64.2	68.6	81.4
Obstruction	39.1	9.0	30.2	18.3
Ulcer	7.4	13.9	3.5	5.3
Leather-bottle stomach	0.9	7.0	0.0	4.2
Negative findings or condition reported non-malignant	5.1	10.1	11.6	3.1

\* As more than one finding may be recorded in a single case, the percentages do not add up to 100.

At subsequent operation the site of the disease was found to have been correctly indicated by X-rays in 90 per cent of the pyloric cases, 75.5 per cent of the cardia cases, and in 60 per cent of those in the mid-gastric region.

**Test-meal (Table IV)**—An estimation of the free hydrochloric acid by means of a test-meal was carried out in 33 per cent of all patients.

**Gastroscopy**—Gastroscopy (or œsophagoscopy when appropriate) was carried out in 10.4 per cent

Table IV—EXAMINATION OF TEST-MEAL (Percentages)

	PYLORUS	MID-GASTRIC	CARDIA	REGION NOT STATED
Total number of patients examined	180	92	29	163
Hyperchlorhydria, above 45 c.c. of N/10 HCl	8.8	8.7	0.0	3.0
Normal acidity, 20–45 c.c.	15.0	9.7	10.3	8.0
Hypochlorhydria, below 20 c.c.	12.8	16.3	10.3	12.9
Achlorhydria	63.3	65.2	79.3	76.1

of all patients, and in 1 to 17 per cent of those with growths in the mid-gastric or cardiac regions was the only means by which a definite diagnosis could be made.

**Distant Metastases**—Clinically recognizable distant metastases were present in 32.5 per cent of all patients on admission to hospital. In 6.9 per cent the cervical or supraclavicular lymph-nodes were affected and in 5.4 per cent metastases were palpable on rectal examination. Of 457 recognizable metastases 85.3 per cent were in the liver or abdominal organs, 3.5 per cent in the lungs, and 3.6 per cent in the bones.

**Treatment (Table V)**—The manner in which the 1405 patients were dealt with in hospital is shown in Table V.

Table V—TREATMENT OF 1405 PATIENTS  
DIAGNOSED AS CANCER OF STOMACH

	PATIENTS	PERCENTAGE OF TOTAL
No operation or radiotherapy	681	48.4
Radiotherapy	33	2.3
Operation	691	49.2
Exploration only	233	16.6
Palliative procedure	215	15.3
Resection	243	17.3

For comparison with these figures we have the statistics of the Mayo Clinic for the years 1907–38 (Walters, Gray, and Priestley, 1942). This is shown in Table VI.

Table VI—CARCINOMA OF THE STOMACH  
GENERAL DATA  
(Diagnosis established in 10,890 Cases 1907 to 1938 inclusive)

	PATIENTS	PERCENTAGE OF TOTAL (10,890)
No operation	4648	42.7
Operation	6242	57.3
Exploration only	2431	22.3
Palliative procedure	1039	9.5
Resection	2772	25.5

Morley (1937) resected in 28 per cent of 207 cases, and Lahey (1935) in 26 per cent of 195 cases. Walton's (1936) figure of 36 per cent appears to refer to cases operated on and not to the total seen. 26 per cent of all cases diagnosed may be taken as the average resectability rate at present.

**Operations and Results (Table VII)**—The figure for 'operation fatalities' includes all deaths from any cause within one month of an operation, whether radical or palliative.

The five-year survival rate for males for all radical operations was 19.8 per cent and for females 27.1 per cent.

Limitation of space compels the presentation of the figures in a single table, but the tables for the

It appears, therefore, that in London 49.2 per cent of all cases seen were submitted to operation and 17.3 per cent were resected, whereas in the Mayo Clinic series the percentages were 57.3 and 25.5 respectively. The operative mortality in London

Table VII—OPERATIONS AND RESULTS

OPERATION	NUMBER	OPERATION FATALITIES	SURVIVED 5 YEARS	DIED WITH CANCER	DIED WITHOUT CANCER	UNTRACED	OPERATION MORTALITY PERCENTAGE	SURVIVED 5 YEARS PERCENTAGE OF TRACED CASES
<i>Radical —</i>								
Total gastrectomy	20	18	—	2	—	—	90.0	—
Subtotal gastrectomy	9	4	—	4	—	1	44.4	—
Partial gastrectomy (Billroth I)	27	8	8	9	1	1	29.6	44.4
Partial gastrectomy (Polya)	181	46	28	97	5	5	25.4	21.5
Partial gastrectomy with removal of part of oesophagus	4	4	—	—	—	—	100.0	—
Local removal of growth	2	—	—	2	—	—	—	—
Total radical operations	243	80	36	114	6	7	32.9	23.1
<i>Palliative and Exploration —</i>								
Palliative gastrectomy	21	12	1	8	—	—	57.1	11.1
Gastro enterostomy	136	39	5	90	—	2	28.7	5.3
Gastrostomy or jejunostomy	36	16	—	20	—	—	—	—
Other palliative procedures	22	4	1	17	—	—	18.2	5.5
Exploration only	233	55	1	175	—	2	23.6	0.6
Total operations	691	206	44	424	6	11	29.8	9.3

\* Operation fatalities are excluded in calculating survival rate

individual regions showed that operation mortality was lowest in growths of the pyloric region.

For comparison we may take the following figures compiled from the published statistics of the Mayo Clinic (Walters et al, 1942), shown here as Table

was double that in the Mayo Clinic and the five-year survival rate was 23.1 per cent against 28.9 per cent in the latter. Some of the factors which might account for these differences are examined in the following paragraphs.

Table VIII—MAYO CLINIC—HOSPITAL MORTALITY AND SURVIVAL RATE  
(Extracted from Tables XXI and XXV in Walters et al, 1942)

OPERATION	PATIENTS	HOSPITAL DEATHS	PATIENTS WHO SURVIVED OPERATION*	SURVIVED FIVE YEARS	PERCENTAGE OF TRACED CASES†
Total gastrectomy	27	per cent 66.7	6	—	—
Billroth I	170	11.2	136	47	34.8
Billroth II	437	17.6	358	100	28.1
Anterior Polya	659	17.8	485	119	24.8
Posterior Polya	1264	15.2	808	232	28.9
Resection by all methods	2772	16.2	1968	564	28.9
Palliative operations	1039	12.3	802	9	1.1
Exploration only	2431	4.4	1971	12	0.6
Total surgical intervention	6242	11.0	4741	585	12.5

\* Includes only patients operated on five or more years previously

† Hospital mortality is excluded in the calculation of survival rates

Table IX—OPERABILITY AND RESECTABILITY RATES BY AGE (LONDON)

1	2	3	4	5	6
AGE	NUMBER OF PATIENTS	PERCENTAGE DISTRIBUTION OF AGE GROUPS	OPERATION PERFORMED	RADICAL OPERATION	OPERATION MORTALITY OF RADICAL OPERATIONS
Under 40			per cent	per cent	per cent
40-49	75	5.3	78.7	30.7	4.3
50-59	159	11.3	61.6	28.3	17.8
60-69	388	27.6	61.1	21.6	41.7
70 and over	512	36.5	49.0	16.2	38.6
	271	19.3	17.0	3.0	50.0
Totals	1405	100.0	49.2	17.3	32.9

For radical operations  $\gamma = 67.42$

$P < 0.001$

Mean age = 60.3

VIII The five-year survival rate for males for all methods of resection was 28.6 per cent and for females 29.8 per cent.

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Age in relation to Operability and Operative Mortality (Table IX)—In this table the patients are arranged in six age-groups, showing the

percentage of operations and of radical operations in each age-group with the operation mortality of the radical operations

*Table X* gives the corresponding figures for the Mayo Clinic series

double the Mayo Clinic figure, which included all deaths in hospital

**Delay in Diagnosis**—The delay due to failure to seek medical advice early or to failure to send patients promptly for investigation has been dealt

*Table X*—SURGICAL AND RESECTABILITY RATES BY AGE (MAYO CLINIC)  
(Compiled from Walters et al, 1942, *Tables XVIII and XX*)

1	2	3	4	5	6
AGE	NUMBER OF PATIENTS	PERCENTAGE DISTRIBUTION OF AGE GROUPS	OPERATION PERFORMED	RESECTION PERFORMED	HOSPITAL DEATHS AFTER RESECTION
Under 40	750	6.9	per cent	per cent	per cent
40-49	2217	20.4	66.5	27.6	4.8
50-59	3622	33.3	58.5	25.4	9.6
60-69	3404	31.2	60.5	27.4	16.5
70 and over	897	8.2	53.7	24.4	21.5
Totals	10,890	100.0	57.3	25.5	16.2

Mean age = 56.2

The figures in column 3 show that the London patients were older than those in the Mayo Clinic series, 55.8 per cent of the former were over 60 years of age and 39.4 per cent of the latter. Up to the age of 50 years the proportion of patients submitted

*Table XI*—INTERVAL FROM FIRST SYMPTOM TO TIME OF GASTRECTOMY

INTERVAL	LONDON		MAYO CLINIC*	
	Number	Percentage	Number	Percentage
0-3 months	51	21.0	403	14.5
3-6 months	47	19.3	497	17.9
6-12 months	63	25.9	342	12.3
Over 12 months	63	25.0	1530	55.3
Not known	19	7.8	—	—
Total	243	99.9	2772	100.0

\* Compiled from Walters et al, 1942, *Table V*

to radical operation was higher in London than in the Mayo Clinic, from 50-60 years it was 6 per cent lower, and for later ages lower still. A striking feature of the Mayo Clinic figures is the comparative

with above, where it was noted that the figures for the 691 operated patients showed no significant differences from those for all patients

**Duration of Symptoms at the Time of Gastrectomy** (*Table XI*)—In this table the duration of symptoms deduced from the patients' statements in the 243 cases submitted to gastrectomy is set out and contrasted with the corresponding figures from the Mayo Clinic. These two sets of figures are not strictly comparable, as in 19.6 per cent of the London patients there was a history of previous dyspepsia, which may or may not have been caused by an early cancer, and if counted as such would increase the numbers with intervals of over 12 months. In London only 40 per cent of the patients had had symptoms for less than six months, and only 32 per cent of the Mayo Clinic patients

**Location of Growth** (*Table XII*)—This table shows the differences in resectability, operation mortality, and survival rate between the regions of the stomach.

**Loss of Weight and Operability** (*Table XIII*)—Figures are given showing the effect of loss of

*Table XII*—PERCENTAGE OF RADICAL OPERATIONS, OPERATIVE MORTALITY AND SURVIVAL, BY REGIONS

REGION	NUMBER OF PATIENTS	RADICAL OPERATIONS		OPERATION MORTALITY	SURVIVED FIVE YEARS* PERCENTAGE OF TRACED CASES
		Number	Percentage	Percentage	
Pylorus	470	168	35.7	25.0	21.1
Midgastric	287	61	21.3	41.0	30.3
Cardiac	114	12	10.5	91.6	—
Unknown	534	2	0.4	100.0	—

\* Operation deaths are excluded in calculating survival rates

uniformity of the percentage of resectable growths in all age-groups and the high proportion of patients of 70 years of age and upwards who underwent resection, in marked contrast to the London figures. For all age-groups, except the youngest, the London figures for operative mortality, which included all deaths within 30 days from any cause, were about

weight during the six months prior to admission to hospital on the operability and resectability rate

*Table XIV* shows the resectability rates in patients who had no palpable abdominal tumour and in those who had mobile and fixed tumours respectively. 51.9 per cent of the patients who underwent radical operation had no palpable tumour, about the same

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percentage as Walton (1930) found Figures from the Mayo Clinic for comparison with Tables XII, XIII, and XIV are not available

the resected cases it was 11 per cent less The percentage of patients in whom metastases were found in the liver is higher in the London series

Table XIII—LOSS OF WEIGHT, OPERABILITY, AND RESECTABILITY

WEIGHT LOSS	NUMBER	OPERATION PERFORMED	RADICAL OPERATION PERFORMED	
			Number	Percentage
No weight loss	54	per cent 70.4	18	33.3
Moderate weight loss, up to 2 st, or one-sixth of body-weight	246	59.8	62	25.2
Great weight loss, over 2 st, or over one-sixth of body-weight	272	56.3	59	20.9
Weight lost, but amount not known	738	42.4	94	12.7
Not stated	95	36.8	10	10.5
For radical operations $\chi^2 = 27.8$ $P < 0.001$				

Table XIV—PRESENCE OF PALPABLE TUMOUR AND RESECTABILITY

TUMOUR	NUMBER OF PATIENTS	PERCENTAGE OF ALL PATIENTS	RADICAL OPERATION PERFORMED	
			Number	Percentage
No tumour	584	41.6	126	21.6
Mobile tumour	312	22.2	86	27.6
Tumour mobile on respiration	142	10.1	16	11.3
Fixed tumour	234	16.6	11	4.7
Doubtful tumour or not stated	133	9.5	4	3.0
For radical operations $\chi^2 = 79.0$ $P < 0.001$				

**Lymph-node and Abdominal Metastases** (Table XV)—In this table the percentage of patients in whom metastases were found at operation is arranged in accordance with the type of operation performed

The conclusion to be drawn from a study of Tables IX, XIII, XIV, and XV is that the London patients were on the average older than those seen at the Mayo Clinic and the disease more advanced. The former also include many patients who were

Table XV—OPERATION FINDINGS—METASTASES

METASTASES	TOTAL CASES 691		RESECTIONS 243	PALLIATIVE OPERATIONS 215	EXPLORATIONS 233
	Number	Percentage			
No metastases noted	124	17.9	per cent 34.2	per cent 12.1	per cent 6.4
Lymph-nodes—local	338	48.9	60.5	45.6	40.0
Lymph-nodes—retro-peritoneal	152	22.0	3.7	24.6	38.6
Not stated	77	11.1	1.6	17.3	15.0
Metastases in liver	113	16.4	—	16.3	33.5

Table XVI—CARCINOMA OF STOMACH, 1907-38

LOCATION	TOTAL CASES 6242		RESECTIONS 2772	PALLIATIVE OPERATIONS 1039	EXPLORATIONS 2431
	Number	Percentage			
No metastases noted	2319	37.2	per cent 45.3	per cent 37.2	per cent 27.8
Lymph nodes—stomach	3161	50.6	53.5	52.2	46.8
Lymph nodes—retro-peritoneal	417	6.7	1.1	12.6	10.5
Liver	747	12.0	1.9	12.8	23.1

The findings in the Mayo Clinic series are set out in Table XVI (extracted from Walters et al, 1942). Comparison of Tables XV and XVI shows that in the London series the percentage without lymph-node metastases at the time of operation was 19 per cent less than in the Mayo Clinic series and that in

admitted to hospital in the very late stages of the disease, whereas the American patients must have been able to undertake the journey from their homes to the Clinic, thus introducing an element of selection.

**Estimation of Survival after Surgical Treatment** (Table XVII)—Dr Percy Stocks, Medical

Statistician, General Register Office, to whom this question was referred, advised that in comparing survival rates of cancer patients treated by operation with those treated by other means or not treated, a fallacy is introduced if operation fatalities are excluded

The mean actual duration of 1189 fatal cases of known duration in months was  $12.42 \pm 0.33$ , standard deviation  $11.18 \pm 0.23$

**Survivors**—There were 56 patients surviving after five years (4.03 per cent of all cases) Of these,

Table XVII—EXPECTATION OF FIVE-YEAR SURVIVAL

GROUP	A	B	C	D	E
Number of cases	61	24	91	32	1255
Mean number of months lived	59.41	58.00	59.74	60.00	59.88
Maximum possible in 5 years from onset	60	60	60	60	60
Expected	56.61	54.65	56.42	56.99	54.57
Actual	34.36	34.66	24.33	23.03	14.90
Percentage of expected	60.69	63.42	43.12	40.41	27.44

from the treated group while leaving in patients who died within a short period without treatment, as the operation fatalities must be taken account of in weighing up the patient's chances of living five years. He therefore advised the use of an actuarial method, which means calculating from a life table the total months expected to be lived during the five-year period by a group of persons in the general population having the same sex-age distribution as the group of patients dealt with, from which the mean is calculated. The mean number of months actually lived by the group of cancer patients from first

36 had been treated by partial gastrectomy, 7 by palliative operations, 2 by radiotherapy, 1 had exploratory laparotomy only, and 10 had not been treated. Details of the 36 patients who had had partial gastrectomy performed are given in Table XVIII

The mean age of the 17 male survivors at the time of operation was 50.2 years and of the 19 females 53.6 years. The mean duration of symptoms at the time of operation was less than six months in 35 per cent of the males and in 26 per cent of the females, from 6–12 months in 47 and 31 per cent respectively

Table XVIII—PARTIAL GASTRECTOMY—SURVIVORS

RADICAL OPERATIONS		OPERATIVE MORTALITY		SURVIVED FIVE YEARS*	
Sex	Number	Number	Percentage	Number	Percentage of Traced Cases
Male	143	53	37.8	17	19.8
Female	100	27	27.0	19	27.1

\* Hospital mortality is excluded in the calculation of survival rates

symptom to death or the end of the five-year period, whichever happens first, is calculated and expressed as a percentage of the normal expected for that group, making allowances for cases followed up for less than five years. In Table XVII the expectation of life in months worked out in this manner is shown for the following five groups of cases—

**Group A**—61 cases of pyloric carcinoma without lymph-node metastases treated by partial gastrectomy

**Group B**—24 cases of midgastric carcinoma without lymph-node metastases treated by partial gastrectomy

**Group C**—91 cases of pyloric carcinoma with lymph-node metastases treated by partial gastrectomy

**Group D**—32 cases of midgastric carcinoma with lymph-node metastases treated by partial gastrectomy

**Group E**—All cases of known duration, treated or untreated

These figures show that partial gastrectomy in the early stages, before the lymph-nodes were involved, gave an expectation of survival for five years of 60–63 per cent of normal, whilst after involvement of the lymph-nodes the expectation was reduced to 40–43 per cent of normal

At operation 10 (58.8 per cent) of the male patients and 13 (68.4 per cent) of the females were found to have no metastases in the lymph-nodes. The diagnosis was microscopically verified in all but 3 of the 36 patients

The mean age of the 10 survivors who were not submitted to operation was 64.2 years. Two patients refused the exploration which was advised and one underwent gastro-enterostomy subsequently. The diagnosis in all cases was based on a positive X-ray report and in 5 there were gastroscopic examinations, in 1 of which the condition was pronounced to be malignant. There were no biopsies. A definite opinion that the condition was non-malignant has since been given in 4 patients and appears to be justified in the others

**Basis of Diagnosis (Table XIX)**—This table shows the evidence on which the diagnosis was based in all 1405 cases

There were 34 patients in whom the nature of the case was not diagnosed clinically, but was revealed at operation or post-mortem. There were, in addition, 24 patients in whom the diagnosis was subsequently changed (after operation in 1 case, on post-mortem evidence in 5 cases, and in view of the clinical course of the case in the other 18), and the cases were deleted from the register before the end

# DISK LESION CAUSED BY LUMBAR PUNCTURE

of the five-year follow-up Adding the 10 survivors referred to in the last paragraph, the percentage of wrong diagnoses in the whole series was 2.4 per cent

**Cancer supervening on Peptic Ulcer**—No attempt was made to draw conclusions on this point

Table XIX—BASIS OF DIAGNOSIS

	NUMBER	PERCENTAGE
Clinically Malignant —		
Confirmed by histological and/or post-mortem examination	544	38.7
Confirmed by appearance of metastases	413	29.4
Based on clinical evidence only	415	29.5
Clinically Benign —		
Proved malignant by histological examination	24	1.7
Proved malignant by appearance of metastases	9	0.6

from the histories, as sufficient details were not available. However, the histological report suggested that the cancer supervened on a peptic ulcer in 40 cases, 8.6 per cent of those in which a histological examination was made. Of these patients, 23 had growths in the pyloric region and 17 in the midgastric region. In 10 patients there was a definite history of treatment for gastric ulcer and in 10 there was a long history of indigestion.

## SUMMARY

- 1 The main findings in a series of 1405 patients with cancer of the stomach treated in the hospitals of London during 17 months in 1938 and 1939 are reviewed.
- 2 The operability rate in these patients was 49.2 per cent and the resectability rate was 17.3 per cent.
- 3 The operation mortality for all radical operations averaged 32.9 per cent, ranging from 25.4 per cent for the Polya method of partial gastrectomy to 90.0 per cent for total gastrectomy.
- 4 The survival rate for all radical operations averaged 23.1 per cent of traced cases, after excluding operation fatalities, ranging from 21.5 per cent for the Polya method to 44.4 per cent for

the Billroth I method. These figures are compared with those published by the Mayo Clinic.

5 Statistics of age incidence, weight loss, frequency of lymph-node metastases, and other factors are analysed and compared with similar figures from the Mayo Clinic, leading to the conclusion that the patients in the London series were on the average older and the disease more advanced.

6 Estimation of survival by an actuarial method shows that resection before the lymph-nodes were involved gave 60–63 per cent of normal expectation of life over a five-year period of observation. After involvement of the lymph-nodes, resection gave only 40–43 per cent of normal expectation. The average for all cases, including those not treated, was 27.4 per cent of normal.

7 Details of 36 patients who survived five years after partial gastrectomy are examined. Their mean age was 3–6 years less than the general mean of those operated, and 58–68 per cent had no lymph-node metastases at the time of operation. Females showed the best survival rate.

I have to thank the British Empire Cancer Campaign for permission to make use of the case records collected by the Clinical Cancer Research Committee, and Dr Percy Stocks for help and advice on statistical points.

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# LESION OF THE INTERVERTEBRAL DISK CAUSED BY LUMBAR PUNCTURE

By ALFREDA H. BAKER

THEORETICAL considerations would lead one to expect that in difficult lumbar punctures the needle might enter and injure the intervertebral disk. In the child such injury is more likely than in the adult because the disk in children is of a more resilient structure, the nucleus pulposus is of a more fluid consistence and under greater tension. Injury to the intervertebral disk is not, however, a hazard of lumbar puncture that is usually regarded as important, nor is it generally recognized that its consequences may be serious. The case history related here does, therefore, serve to draw attention to a little-recognized injury and one which should

be known to all who use lumbar puncture in diagnosis and treatment. Charles Pease (1935) gave a very good account of the mechanism and effects of the injury. His paper does not seem to have been followed by any widespread interest in the American medical press and is little known in this country.

## CASE HISTORY

B. C., aged 4 years, was admitted to Oster House Emergency Hospital, St Albans, under the care of Dr Ursula James, on Jan 9, 1945, for investigation of the cause of mild fits. These fits, apparently epileptiform in type, have not been a marked feature of the case and

have no significance in the after-history. In the course of the examination of the CNS, lumbar puncture was done on Jan 11 and Jan 12. This was successful only after several attempts. More than one interspinous interval was punctured. He was discharged on Jan 15. Five days later his mother brought him to hospital because she had found that he had backache. The child

were clear, the abdomen soft, and the reflexes present and equal on the two sides. No muscular tenderness was found anywhere and there was no tenderness of the spine. All the same, the child resented being touched or moved, and although he moved his legs as he lay in bed, passive flexion of the spine, by bringing the knees upwards on to the chest, was very painful. The child's

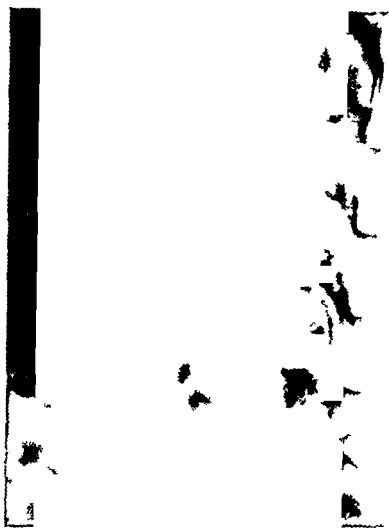


FIG 526—Radiograph, Jan 20, 1945, after the onset of backache

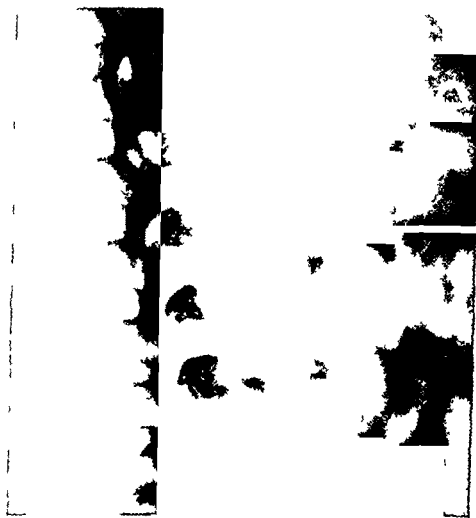


FIG 527—Radiograph 11 days after the onset of symptoms. Narrowing of space between L 2 and L 3



FIG 528—Radiograph 19 days after onset of symptoms. Marked narrowing of space between L 2 and L 3 and between L 3 and L 4



FIG 529—Radiograph showing erosion of upper surface of L 4 64 weeks after onset

was admitted for one night for observation. A radiograph taken on that day was reported as showing no abnormality of the spine (Fig 526). Lumbar puncture was repeated and this time no difficulty was encountered. The child seemed well and was sent home on Jan 22. The cerebrospinal fluid was normal.

One week later the mother brought him back and this time she was seriously alarmed because he was listless and unwilling to sit up or walk. He cried out in his sleep and complained of pain in his back when moved. He was re-admitted at once (Jan 29). The temperature on admission was 99°, he was pale and reticent and looked apprehensive. The heart and lungs

movements were most abnormal. He walked cautiously, holding his back very stiff, and when asked to sit up in bed, he raised himself from the lying to the sitting posture by supporting his weight on his hands with his elbows extended. He awakened at intervals during the night screaming with pain.

I was asked to see him for the first time on Feb 2. It was obvious that he had an acute spinal lesion, but the nature of the lesion was obscure. Radiography of the spine was repeated (that is, 11 days after the first X-ray examination), and now showed a slight narrowing of the intervertebral space between L 2 and L 3 (Fig 527). There was no X-ray evidence of a bone lesion. The

temperature was now 100°, the WBC 10,875, and the Mantoux test was negative in 1-1000 and 1-100. The next day the child was put in a plaster bed.

The clinical history during the next week was complicated by a sharp attack of chicken-pox, with a well-marked rash and a few signs in the chest. For ten days he had an irregular temperature, at times rising as high as 102°. It was difficult to decide how far the febrile reaction was accounted for by the chicken-pox, and how far, if at all, it was due to his spinal lesion. The progress of the spinal lesion is best followed on the radiographs. These show that fairly rapid progression of the original lesion between L 2 and L 3 was complicated by narrowing



FIG 530—Radiograph, Oct 10, 1945. Bone healed and subluxation corrected with permanent narrowing of intervertebral spaces.

of the disk between L 3 and L 4 (Fig 528) and that by March 6 there was slight erosion of the upper surface of the body of L 4 (Fig 529). By April 6 this slight erosion was surrounded by sclerosed bone, and the alignment of the vertebrae had improved. This improvement in definition continued, and the last radiograph, on Oct 10, showed a well-defined erosion in the upper surface of L 4, but no evidence of activity of the lesion.

A mild pyrexia continued when the attack of chicken-pox had subsided, the evening temperature being about 99°. It was thought possible that the child might have a low-grade staphylococcal osteomyelitis of the spine and he was therefore treated for five days with penicillin by continuous intramuscular drip. He had 50,000 units daily from Feb 13 to Feb 18. He became afebrile on Feb 20, and, with the exception of five days from March 25 to March 29, he remained afebrile for the rest of his illness. During those five days the temperature rose to 100° or 101° on three occasions and the child complained of backache and was restless. His health from that date steadily improved, and during the last weeks in the plaster bed he was so active and lively that it was extremely difficult to keep him recumbent. Treatment in the plaster bed was maintained until June 22, i.e., for five months. From June 22 to Aug 7 he was ambulant, wearing a plaster jacket. He has had no treatment since. Flexion of the lumbar spine was somewhat limited when he was seen in November, 1945. He appears to have very slight functional disability, despite the marked skeletal changes shown in the radiograph (Fig 530).

### DISCUSSION

The important points in the history of this case are the onset of backache a few days after the

performance of a difficult lumbar puncture, the rapid progression of the radiological evidence of spinal injury, and the apparent value of penicillin in the early stages of treatment. Experience of this case had made me view lumbar punctures, in children especially, with added respect. In the event of backache following a lumbar puncture, whether for diagnosis, treatment, or anaesthesia, a radiograph of the lumbar spine should be done, and if negative, should be repeated within ten to fourteen days. The literature on the subject of lumbar puncture injuries is not extensive. Pease (1935) seems first to have recognized the real significance of the sequence of lumbar puncture and prolapse of the intervertebral disk. Billington (1924) had previously discussed the relationship between spondylitis and lumbar puncture in cases of meningococcal meningitis. He said, "the spinal needle may easily afford a direct means of inoculating the lower lumbar vertebrae and disks with the meningococcus." Of the 35 cases of spondylitis in his series, 8 had partial or complete destruction of a disk in the lumbar region. Pease allows that inflammatory reaction may be set up in the bony and articular elements of the spine, but he is obviously more impressed with the mechanical effects of the injury inflicted by the needle, and it is to this that he attributes the narrowing of the disk. His account of the condition is based on 12 cases. In 3 cases, all children, he gives a complete clinical history. The spinal puncture was done in one case to inject air for an encephalogram, in the second for the administration of serum in a relapsing case of meningitis, and in the last for diagnosis in a case of poliomyelitis. Pease relates his experience in yet another case which was admitted moribund from miliary tuberculous meningitis. A lumbar puncture was done for diagnosis and the needle met an obstruction. An immediate radiograph was taken with the needle in situ. It was found that the needle had penetrated the intervertebral disk and was impinging on the inferior border of the fourth lumbar vertebra. The needle, after withdrawal, was found to contain material from the nucleus pulposus. Fortunately, a radiograph had been taken before the lumbar puncture and was normal. The radiograph taken immediately after the needle was withdrawn showed a narrowing of the intervertebral space between the fourth and fifth lumbar vertebrae.

Milward and Grout (1936) reported 5 cases, all in adults, whose ages varied from 24 to 51 years. In these patients, lumbar punctures had been done for induction of spinal anaesthesia and the latent period between the puncture and the onset of symptoms varied considerably. The symptoms were, in all cases, severe backache, rigidity of the spine, spasm of the erector spinae muscles with the spine in a flexed position, and tenderness found on pressure over the spines of L 2, 3, and 4. Milward and Grout conclude that the initial injury is caused by the lumbar puncture needle impinging on the annulus fibrosus, and that this is followed by an inflammatory reaction in the disk leading to a gradual escape of nucleus pulposus.

Gellman (1940) describes one case following several unsuccessful attempts at lumbar puncture for diagnostic purposes in a syphilitic girl aged 14.



Everett (1942) agrees that the probable cause of the condition is a slow seepage of the nucleus pulposus through the annulus fibrosus. This, he says, may occur directly through a tear in the annulus fibrosus, or by weakening of the annulus through an inflammation set up by the introduction of the needle. He has experience of 3 cases, 2 following diagnostic lumbar punctures, and 1, spinal anaesthesia.

Epps (1942) relates the history of a man who had five punctures done for meningitis, the last of which took thirty-five minutes. The patient complained of shooting pains down his legs as repeated attempts were made to pierce the theca. Three to four weeks later sudden severe low backache occurred, which caused him to collapse in three days.

The history of all these cases is of severe backache following a lumbar puncture, and, sooner or later, disabling the patient. The cases following spinal anaesthesia seem to show a longer latent period between the puncture and the onset of symptoms, and on the whole the symptoms seem to come on more rapidly in children than in adults. The X-ray findings are always of a narrowing of one or more intervertebral disks. Some cases show minor lesions of the vertebral bodies adjacent to the affected disks. In my case there was a tendency to subluxation. Opinion is almost unanimous that the initial lesion is a tearing of the annulus fibrosus by the needle, the part, if any, played by sepsis is not clear. Most authors content themselves by citing 'inflammation' as a possible or probable contributory factor. Where the puncture has been done in a case of meningitis, the organism infecting the meninges is a possible cause of the inflammation of the disk. In my case the clinical improvement of the child after a short course of penicillin lends

support to the view that a low-grade sepsis did, in fact, complicate the case. The mechanical factor seems on all counts to be much more important, and persistence in attempts at lumbar punctures by an unskilled operator is most certainly to be avoided. These cases provide a warning against extreme flexion of the spine when the needle seems to meet an obstruction. The possibility must be kept in mind, more especially in children, that this may lead to increased prominence of the disk backwards, and increased danger of its injury by the needle.

**Treatment**—A few of the less severe cases have been successfully treated by rest in bed for a matter of weeks. For all severe cases some type of spinal support is essential. The best form of treatment is probably a plaster-of-Paris bed for at least three months, followed by a plaster jacket for a further three months. Full recovery can be expected if the treatment is efficient.

### SUMMARY

A case is described in which diagnostic lumbar puncture in a child was followed within a few days by severe backache and rigidity of the spine. Radiographs demonstrated the rapid development of prolapse of the intervertebral disks. Treatment by spinal support was successful. The aetiology of the lesion is discussed.

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## A REPORT ON FOUR CASES OF CONGENITAL GENU RECURVATUM OCCURRING IN ONE FAMILY

By AUBREY L. MCFARLANE, KINGSTON, JAMAICA

THE condition known as congenital genu recurvatum or congenital dislocation of the knee was described as early as 1822 by a Swiss observer, Potel.

According to the literature on the subject, the condition consists of a fixed hyperextension of the leg at the knee-joint, often associated with other congenital abnormalities, especially club-foot and congenital dislocation of the hip, the condition may be unilateral or bilateral. Usually the patella remains undeveloped until the condition is corrected and normal functional stresses are restored.

Various theories as to its causation have been advanced, but Middleton (1935), who made a thorough investigation of this condition, came to the conclusion that the condition is due to an intra-uterine degeneration of muscles giving rise to a muscular contracture. Nickerson (1945), quoting Berkheiser, states "In the human being, born with genu recurvatum, the patella fails to develop until the deformity is corrected surgically and natural functional stresses are restored, after which the patella enlarges and develops."

The following series consists of four cases, a coloured woman and her three children. All the children had different fathers, none of the fathers had any congenital abnormality, and, so far as could be ascertained, all the grandparents were normal. It was not possible to obtain any history farther back in the family tree.

### CASE REPORTS

**Case 1**—J. M., a female child, was first seen in 1937, at the age of 10 months, suffering from bilateral congenital genu recurvatum (Fig. 531). Manipulative reduction followed by plaster casts failed to produce satisfactory results. Surgical operation was performed through a straight incision on the anterior surface of each knee-joint, the quadriceps tendon was dissected out from the muscles, reduction of the deformity was easily accomplished, the joint was held in about 15° of flexion by an assistant, the V-shaped wound was sewn up as a Y, and the skin closed by interrupted silkworm-gut sutures.

The limbs were placed in plaster for six weeks, and, when the cast was removed, there appeared to be some slight tendency for the dislocation to recur. The cast

was renewed and the child allowed to exercise in the casts. At the end of three months she was sent to the electrotherapy department for massage and exercises

later, on the left knee. The legs were placed in plaster casts, the club-feet were corrected by manipulation and included in the cast. The casts were renewed at intervals



FIG 531—Case 1 Lateral and anteroposterior radiographs of both knees before operation

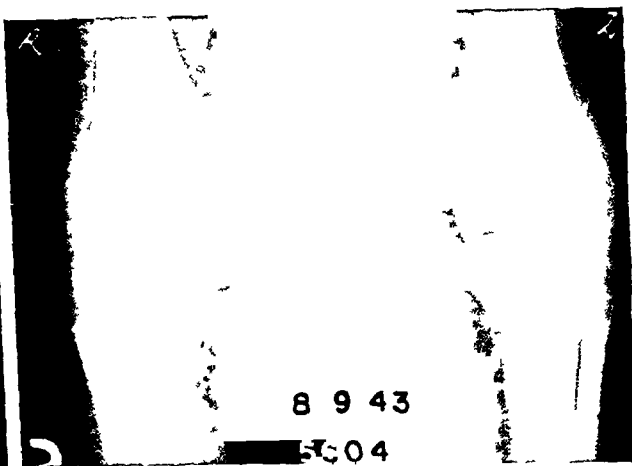


FIG 532—Same case Radiographs taken 6 1/2 years after operation

When last seen, in November, 1945 (Fig 532), the joints showed normal function and range of movement, but there was a slight degree of bilateral genu valgum

Case 2—A I, a male child, was seen in 1943, at the age of 17 months. He had the following congenital abnormalities: Bilateral genu recurvatum (Fig 533), bilateral talipes equinovarus second degree, a cleft of the posterior half of the soft palate, abnormally large second and third toes of both feet

Manipulation failed to reduce the dislocation, so operation was done on the right knee, and, eight weeks

for several months, and eventually the child was given club-foot boots and light metal splints

When last seen, in November, 1945 (Fig 534), his gait, legs, and feet appeared normal, and the knees showed a normal range of movement

Case 3—C W, a female infant, was seen in March, 1945, aged 3 months, suffering from (1) Gastro-enteritis, (2) Bilateral congenital genu recurvatum

X-ray pictures were taken of both knees (Fig 535), and these show the typical deformity. No treatment was given for the genu recurvatum, as she died of gastro-enteritis shortly after admission

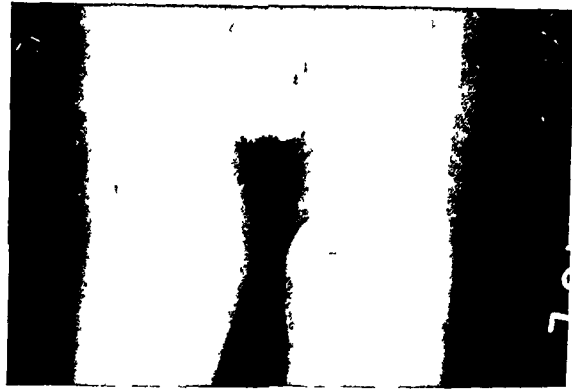
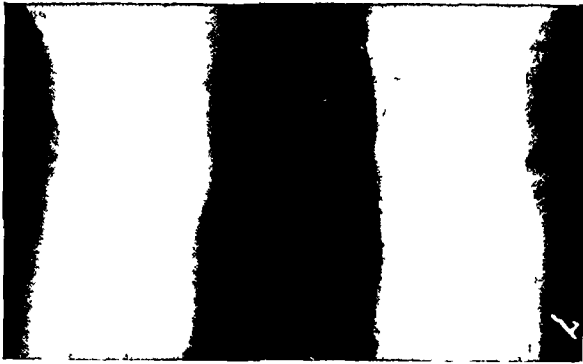


FIG 533—Case 2 Lateral and anteroposterior radiographs of both knees before operation



FIG 534—Same case Radiographs taken 1 yr 4 mth after operation



FIG 535—Case 3 Lateral and anteroposterior radiographs of both knees

Case 4—L W, aged 27 years, the mother of the three preceding cases, was asked to attend at the hospital for examination. She appeared mentally normal, capable of earning her living as a basket-maker, considerably below average height, with unusually short nose with low bridge, marked spinal scoliosis, and some forward bulging of the sternum. The knees showed a small range of movement only, and the condyles of the femora could be felt below and behind the upper ends of the tibia. In addition, there was hyperextension at the elbows, some bony deformity of the heads of the radii, the second and third toes of both feet were abnormally

very far. It would have been interesting to know whether any of the great-grandparents had any similar deformities. As the fathers were all different, the likelihood of inheritance from the paternal side may be excluded.

Two of the cases received surgical treatment at an early age, when operation proved the condition to be easily corrected by surgical means, after reduction by manipulation had failed. These two cases, when seen last, appeared to be developing normally, proving that early surgical treatment may

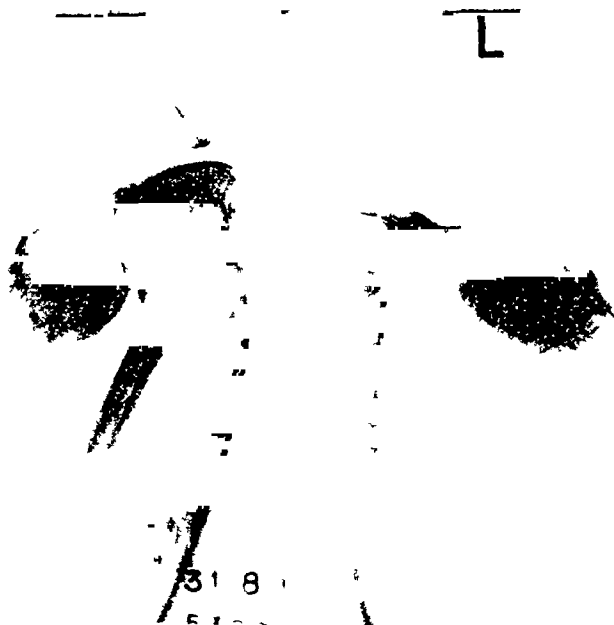


FIG 536—Case 4. Lateral radiographs of both knees. The lower end of the right femur is behind the upper end of the tibia. Note also the anterior bowing of the tibia, the deformed lower end of the femur, and the presence of well-developed patellæ.



FIG 537—Same case. Anteroposterior radiographs.

long and webbed at the bases. She walked with a peculiar rocking gait, due to her inability to flex the knee-joints.

Radiographs of the hips (not shown), revealed bilateral coxa valga; radiographs of the knees (Fig 536), show well-developed patellæ on both sides. On the right side, the lower end of the femur is deformed, and displaced backwards and downwards in relation to the tibia; there is a depression on the anterior surface of the femur, just above the condyles, which articulates with the posterior lip of the upper end of the tibia. A similar condition is present on the left side (Fig 537). These patellæ are both well-developed.

### DISCUSSION

Four cases of congenital genu recurvatum are presented in this series, the three children having inherited this congenital deformity through the mother. The family history could not be traced

result in normal growth with full range of movement.

Case 4 shows one of the end-results of the untreated case, i.e., complete posterior dislocation of the femur at the knee-joint, also that the patella may develop, even though the normal stresses are altered and the deformity remains uncorrected.

Other congenital abnormalities were present in two of the cases (Cases 2, 4) which are commonly seen in congenital genu recurvatum.

I have to thank Dr C H Parkin, Radiologist of the Public Hospital, Kingston, for his help and advice in these cases, also several other members of the Staff for their assistance, and the Director of Medical Services for permission to publish this article.

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# THE SURGICAL PURSUIT AND REMOVAL OF A METALLIC FOREIGN BODY FROM THE SYSTEMIC VENOUS CIRCULATION

By WILLIAM W DAVEY, SURGEON, R A F  
AND GEOFFREY E PARKER, D S O, Surgeon, R A M C

THIS is the unique tale of the finding, pursuit through the heart and some of the main veins, and final capture of a shell fragment, with survival of the patient

## CASE REPORT

The patient, aged 19, sustained a shell wound in the left clavicular region on Feb 12, 1945, at 17 00 hr. At 21 15 hr his condition was "fairly good, but pale, appears to have lost a fair amount of blood, and there is almost a pint on the stretcher and blankets."



Fig 538—Radiograph taken on March 5, 1945, showing foreign body in upper anterior mediastinum

**FIRST OPERATION**—Notes at the Field Surgical Unit "Penetrating wound over point of left shoulder—large hæmatoma over scapula—direction of wound track medial—clavicle intact. The cephalic vein found torn—ligatured. Wound track laid open in search of hæmorrhage. Small metallic foreign body removed but seems very small to have caused wound and another fragment may have entered the chest or mediastinum. Chest appears clear. Penicillin spray to wound and partial primary suture."

These observations of the Forward surgeon were remarkably accurate in view of the subsequent findings.

Penicillin, 450,000 units, was given in the succeeding four days. X-ray examination showed the presence of a metallic foreign body in the upper anterior mediastinum (Fig 538). There were no chest signs or symptoms and no abnormality of the left upper limb was noted except for numbness of the left thumb and forefinger. It was decided to postpone further operation until the superficial wounds were healed. The patient's general condition being satisfactory, he was evacuated to Base.

At Base on Feb 28 the patient's condition was good. He had a wound extending from the left acromion process to below the inner third of the left clavicle (Fig 539), healed in its inner half, clean and granulating in its outer half. On March 6 X-ray examination confirmed the presence of a foreign body lying in the anterior mediastinum about 1 in deep to the manubrium at the level of the costochondral junction and lying centrally (Fig 538)

It was decided to embark upon a second operation for the following reasons: (a) Complaint of slight retrosternal pain, (b) Slight evening rise of temperature, (c) Possibility of abscess formation, (d) Possibility of secondary hæmorrhage from one of the great vessels in the vicinity.

## SECOND OPERATION (G E P)—

**First Stage** This began at 10 30 a.m. on March 7 under endotracheal gas, oxygen, and ether. A C-shaped incision exposed the second and third left costal cartilages and the sternum at that level (Fig 539). The second costal cartilage and a portion of the manubrium were resected after separating the left pleura digitally and the foreign body was at once felt lying apparently behind the left innominate vein, above and in front of the arch of the aorta. During the dissection to clear the left innominate vein the fragment was felt to roll away from the surgeon's fingers and after a short search it became apparent that it had disappeared completely from the operative field. This led to the conclusion that the foreign body had been actually within the lumen of the vein.



Fig 539—Colour photograph taken on Nov 6, 1945, showing original wound and operation incisions

(Fig 540), that it had been dislodged by the dissection, and now moved proximally with the blood-stream towards the heart. There was no change in the patient's condition, but the table was at once placed in the reverse Trendelenburg position in an attempt to prevent the fragment from passing from the right auricle to the ventricle, which it was thought would result either in

immediate death from cardiac embarrassment or total infarction of one or other lung by blocking of either main pulmonary artery. Immediate X-ray examination (Fig 541) showed the fragment to be lying in the right auricle.

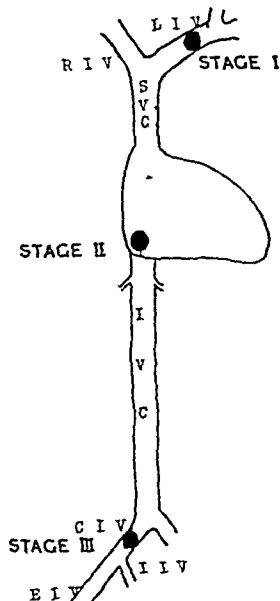


FIG 540—Diagram showing the intravascular course of the foreign body

at approximately the level of the entry of the inferior vena cava. After giving a blood transfusion, the operation was continued one hour later. A further check radiograph confirmed the position of the foreign body (Fig 541).



FIG 541—Radiograph taken at 13 00 hr on March 7, 1945, showing foreign body in the right auricle just above the diaphragm

**Second Stage** The pericardium was exposed through a reverse C-shaped incision incorporating the lower limit of the first incision (Fig 539), the third, fourth, fifth, and sixth costal cartilages and the corresponding part of the left half of the sternum being resected. An oblique incision was made through the pericardium. The heart was exposed and the foreign body felt in the intrapericardial portion of the inferior vena cava (Fig 540). A pair of forceps was introduced into the auricle through a small incision in the middle of a purse-string suture, care being taken to exclude air from the auricle, and the foreign body

was grasped in the forceps. It proved, however, to be fixed obliquely and impossible to remove except by a force which would tear the wall of the vena cava or the auricle, or both, and the grip of the forceps was released. Immediately this illusive fragment moved away, passing down the inferior vena cava. To make sure of this at this stage the reverse Trendelenburg position was increased to the maximum which the table allowed. The opening in the auricle was enlarged to admit a finger to be introduced and passed down the inferior vena cava to verify that the fragment had not lodged in the opening of one of the hepatic veins. The auricle was closed in two layers and the pericardium closed by interrupted sutures after insufflation of penicillin-sulphathiazole powder. Radiography now showed the foreign body lying in the right common iliac vein just below the junction of the common iliac veins (Fig 542).

The patient's condition had deteriorated, but no more than might have been expected having regard to the magnitude of the operative procedure and the sudden loss of blood which occurred during the opening of the right auricle. His condition was not such as to render the further pursuit of the fragment too hazardous. It was felt this should be done at once as there was a danger of the foreign body being drawn back into the heart during coughing or post-operative vomiting, when pressure in the great veins is negative and the patient would not be in the reverse Trendelenburg position.

**Third Stage** The right common iliac vein was exposed through an oblique extraperitoneal incision parallel to the inguinal ligament and the fragment manipulated digitally from its dangerous position in the common iliac vein into the cul-de-sac of the right internal iliac vein (Fig 540). The vein was ligatured proximally and the fragment removed. It was found to be a jagged shell fragment, half the length of and approximately the same diameter as a Woodbine cigarette ( $1 \times \frac{1}{4} \times \frac{1}{4}$  in).

**CONDITION ON CONCLUSION OF OPERATION**—The patient was  $4\frac{1}{2}$  hours on the table. He was considerably



FIG 542—Radiograph taken at 14 45 hr on March 7, 1945, showing foreign body in the right common iliac vein

shocked and of a clammy waxen pallor. His pulse-rate was 160. Throughout the succeeding 12 hours the pulse-rate remained between 160 and 170 and the systolic blood-pressure between 100 and 120 mm Hg. Respirations were rapid (36), shallow, and distressed at times, the paradoxical excursion of the skin and subcutaneous tissues which alone constituted the chest wall over the area of the first two incisions, compensating for a considerable proportion of the negative pressure at each contraction of the diaphragm.

**PROGRESS**—Post-operative treatment was symptomatic and consisted of continuous oxygen through a B L B

mask, morphine, phenobarbitone, and atropine as indicated. Poor expansion of the lungs and suppression of coughing resulted in a moderate degree of pulmonary collapse at the end of the second post-operative day, but this cleared up with the onset of coughing. On the third day 20 c.c. of blood-stained fluid were aspirated from the pericardium by puncture of the skin overlying it. Continuous oxygen given first through a B.L.B. mask and later by use of an improvised oxygen tent were necessary for the first four days, and its absence led to severe dyspnoea and cyanosis in two minutes. After the fifth day there was a period of relative calm until the eleventh day when the temperature rose intermittently to 101° F. Two days later 2 oz. of sterile blood-stained fluid were aspirated from the pericardium and thereafter convalescence was uneventful.

Five weeks after the operation the patient was able to walk 400 yd. without showing any signs of distress, and he was flown back to England in good condition seven weeks from the day of his marathon operation.

**OPERATIVE COMMENT**—During the operation on the auricle extrasystoles were noted, and when lung forceps were applied near the sino-auricular node to steady the auricle for a few seconds a condition of delirium cordis occurred, but this passed off as soon as the forceps were released.

While the finger was exploring the inferior vena cava the patient's condition deteriorated suddenly, presumably from syncope due to diminished venous return to the right ventricle and consequent diminished cardiac output, but recovered quickly when the finger was withdrawn and the auricle closed.

**FOLLOW-UP**—Visited at his home on Sept. 25, over seven months from the injury, he is living a normal life and is working as a technician in technicolour. He gets palpitation with running and feels like "an engine rev'd up." He has discarded the asbestos breast-plate with which he had been fitted to protect the deficiency in his thoracic cage. He says he automatically puts his left arm across his chest in case of trouble. His condition to-day one and a half years after injury is unchanged.

### DISCUSSION

A search of the literature reveals several interesting facts. Gregory (1917) describes a similar case, although the intravascular course of the missile was shorter and less rapid and had a fatal termination. A shrapnel ball entered the liver from the right axilla and ultimately entered the inferior vena cava through the hepatic part of the inferior vena cava and reached the right auricle (confirmed by screening). Subsequently during a fit of coughing, associated with severe distress, the foreign body was found to be in the abdomen. A swelling appeared above the right inguinal ligament and pain in the right iliac fossa which suggested appendicitis. Appendicectomy was performed and the shrapnel ball removed from the external iliac vein on the nineteenth day following injury. Death ensued in three days from general peritonitis.

Menuet (1918) records a case of a patient wounded in the right axilla who died on the second day. It was found that a shell fragment had reached the right ventricle via the liver, inferior vena cava, and the right auricle.

Lyle (1917) had a patient with a shell wound in the left thigh who died on the fifth day from generalized anaerobic infection. Post-mortem examination revealed an opening in the femoral vein and the foreign body free in the right ventricle measuring 1.5 × 0.9 × 0.5 cm.

A patient was described by Tuffier (1918) who received a bullet wound in the right lumbar region. Four weeks later radiography showed the missile to be on a level with L1, 2. Eight days later a radiograph showed the missile in the heart. Attempted removal at this site had to be stopped owing to collapse, and death occurred three days later. Post-mortem examination showed that the bullet had entered the inferior vena cava and come to rest in the wall of the right ventricle.

Following an accidental wound of the abdomen with a 0.38 bullet, Sheppe (1922) performed a laparotomy. He closed multiple small-intestinal perforations and found the bullet resting in front of the vertebral column just above the lumbosacral prominence, as he attempted to grasp it, it disappeared and a massive hæmorrhage ensued from a hole in the inferior vena cava. The patient recovered from the immediate operation but died a few days later from general peritonitis. The bullet was found post-mortem in a fibrin bed near the apex of the right ventricle.

Warthen (1927) made a study of the intravascular fate of metallic foreign bodies introduced into the veins of dogs. He found in all cases they were carried towards the heart. This might take hours or days, but, finally, the heart was reached irrespective of the dog's position or gravity. On reaching the heart the smaller bodies tended to remain there in the right ventricle at the base of the chordæ tendinæ, while the larger ones were carried through to the lungs.

It would appear that the 'normal' course of a foreign body in the venous system is experimentally and clinically towards the heart. This movement can be reversed or impeded by gravity or coughing where a reverse wave of pressure is conducted distally in the inferior vena cava. Free movement of foreign bodies in the superior and inferior vena cava is possible owing to the absence of valves in these veins. Gravity probably succeeded in maintaining the fragment in the auricle and in finally deciding its passage against the blood-stream down the inferior vena cava. Admittedly the force of this stream must have been low in a shocked patient. The maintenance of the foreign body in the auricle might have been achieved even better by placing the patient on his right side (table permitting), in addition to the reversed Trendelenburg position. At all costs the foreign body must be kept from entering the right ventricle, where death has invariably resulted in the cases recorded.

Where surgery is undertaken to remove a foreign body in close apposition to a great vein, it must be stalked with great gentleness, and, if possible, 'trapped' in the vein by proximal occlusion of its lumen. Otherwise, there is a grave risk of onward transmission to the heart.

### SUMMARY

A shell fragment, 1 × 1/4 × 1/4 in., which was lying in the lumen of the left innominate vein passed from there, during operation, into the right auricle and during an attempt to remove it from the auricle, with the patient tilted in the reverse Trendelenburg position, passed down the inferior vena cava to the right common iliac vein and was finally removed.

from the right internal iliac vein. As far as the authors know, such a surgical adventure with the survival of the patient is unique in medical history.

We are indebted to Mr Hennell for the colour photograph.

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## THE ELIMINATION OF 'APPARATUS INERTIA' IN THE TREATMENT OF FRACTURES

By G F DOMMISSE, Ex MAJOR, S A MEDICAL CORPS

AND E J NANGLE, BEIT FELLOW, Ex CAPTAIN, S A MEDICAL CORPS

THE success of the Thomas splint in the treatment of fractures of the femur may be attributed to two main factors—namely (1) The immobilization of the fracture which it affords, and (2) The degree of mobility which it allows the patient in bed.

In this respect it is of interest to recall the fact that Hugh Owen Thomas himself suspended the splinted limb by means of a system of ropes and pulleys, but that his system of suspension was forgotten and only his splint remembered. It was, however, soon recalled.

Successful methods of suspension of the limb, immobilized in a Thomas splint, were devised by Pearson and Drummond, and by Sinclair during the First World War. Hodgen and Hamilton Russell devised methods whereby the Thomas splint was modified or dispensed with entirely, and each of these methods paid due heed to the two factors mentioned above.

To all these forms of treatment, the term 'balanced traction' has been applied, and E L Farquharson (1936) stated "There can be little doubt that the most effective control of the fracture, combined with the maximum comfort of the patient, is to be obtained by the use of some form of suspended splint which is so counterbalanced that it follows the movements of the patient in bed, without the direction of the traction being appreciably altered."

More recent methods of treatment of fractures of the femur display an increasing tendency to afford maximal mobility to the patient during the time that the fracture is immobilized, and all these methods constitute the most adequate proof of the importance of mobilizing the patient at the earliest possible moment.

There remains, however, the less fortunate patient who is suffering from a fracture or disease which necessitates immobilization in a large plaster-of-Paris cast, such as a hip spica or a plaster bed.

This type of patient has been required to remain in the supine position for weeks or months or even years, and to depend entirely upon the nursing staff for the occasional alterations in position which are essential to maintain comfort, the condition of the skin, renal drainage, etc. Small wonder that he becomes as much a psychological problem as a surgical, and that rehabilitation in the society of his fellow men is a somewhat protracted process.

It is apparent that the principal obstacle to movements is the sheer weight of the immobilizing

apparatus, and it is to this factor that we apply the term 'apparatus inertia'.

A method of suspending the limb, immobilized in a Thomas splint, is described, and the method expanded to include all those fractures and diseases of the spine, pelvis, and lower extremities which require immobilization in bed. It eliminates 'apparatus inertia', affords the patient maximal mobility, and does not in any way interfere with the immobilization of the affected part.

The method employs a system of compound pulleys, of the same type as is used by engineers in hoisting weights of great magnitude, for it is only by the use of this type of apparatus that an efficient 'machine' may be obtained.

Details of treatment of the standard types of lesion only are given below, and it is apparent that numerous modifications to suit individual cases may readily be devised.

We first employed this method of treatment in cases which occurred during the final 'push' in Italy in April, 1945, and have continued its use in a wide variety of cases since that time. There have been no contra-indications to its use, and the advantages are discussed below.

Its application to individual types of lesion is as follows—

### A FRACTURES OF THE HIP AND UPPER SHAFT OF THE FEMUR

A considerable proportion of our cases with the above type of lesion were battle-casualty compound fractures. Immobilization was therefore obtained by the use of the double-hip, plaster-of-Paris spica



FIG 543—Wire loop, 10 in in length, which is used for incorporation in plaster cast during application, and which forms a 'suspension point'.

Simple fractures of the femoral neck, on the other hand, were 'pinned' with a cortical peg-graft rather than with one or other type of metal nail, as this method of treatment is, in our opinion, more certain



to result in bony union in young adults. Immobilization in the double-hip plaster spica was once again provided.

'Suspension points' on the plaster cast are created during its application, and they consist of stout wire loops at groin and knee level on both sides. The type of wire loop employed is shown in Fig 543 and the limbs of the loop are incorporated in the cast by a few short plaster slabs and a few turns of the plaster bandage.

It is emphasized that the limbs of the wire loops do not encircle the trunk or limb of the patient, but are applied to the anterior aspect of the cast alone. This eliminates the danger of their cutting into the plaster and causing pressure sores.

Occasionally it is necessary to provide a fifth suspension point at ankle level on the affected side, in order that maximum mobility may be obtained, but it is obvious that there will be individual variations for individual cases, and that it is only by a system of trial and error that complete satisfaction is obtained.

The method of suspension of the patient is diagrammatically illustrated in Fig 544 below.

A sling of stout cord is attached to the two wire loops on each side, and one of the wheels of a compound pulley is made to engage upon these slings. The other wheel of this pulley forms part of the suspensory mechanism, and a pulley system with a mechanical advantage of three is employed on each side. This enables the patient to raise and lower himself with ease, and to support himself on the sound leg within a matter of days after operation. The effects of gravity may be reduced to whatever extent one desires by merely adding to or

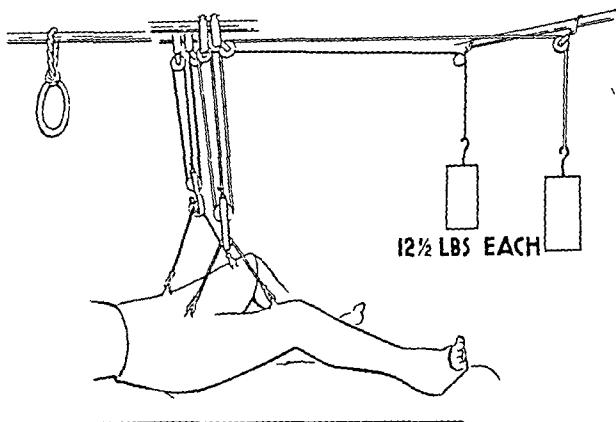


FIG 544—Method of suspension of the double-hip plaster spica. Two weights, each with a mechanical advantage of three, afford a total lifting power of 75 lb, which is adequate for the average patient, but may be increased in the case of the old or frail.

subtracting from the weights at the foot of the bed, and in the average type of patient it is found that two weights, each of 12½ lb, which give a lifting power of 75 lb, are adequate. In the old and frail, or in the large and heavy, these may be increased to a point just short of which they will maintain the patient in a permanently suspended position.

Our oldest patient was a male aged 78 years who suffered from congestive cardiac failure at the time of his admission to hospital.

He experienced no difficulty in raising himself from his bed on the day of his operation, after he had been given assistance to the extent of approximately 66 per cent of his body plus plaster-cast weight. There were no post-operative pulmonary or other complications in this case.

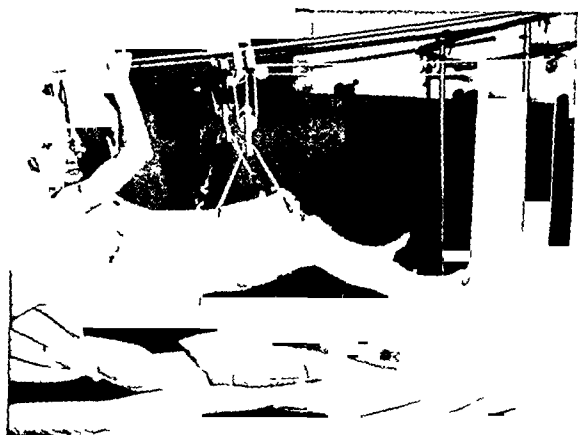


FIG 545—Battle casualty (shell wound). Compound subtrochanteric fracture of the right femur. Note the excellent condition of the patient and the ease with which he is able to raise himself. He is also able to stand on the sound leg and these exercises are performed within a day or two after application of the plaster cast.

It is occasionally necessary to apply traction to a limb which is immobilized in a plaster hip spica. This is readily accomplished by inserting a Steinmann's pin through the tibial tuberosity, and incorporating it in the cast. Sliding traction is then applied to the pin in the standard manner, and it does not in any way interfere with the mobility of the patient.

A photographic reproduction of a patient performing active exercises is shown in Fig 545, and it will be noted that his expression is entirely free from strain, effort, or fear of pain.

When quick-setting plaster-of-Paris is used, it is possible to suspend the patient within an hour or two of the application of the cast, and this is of great value in promoting drying of the posterior half. Other advantages of this form of suspension are discussed below.

## B MID-SHAFT FRACTURES OF THE FEMUR

The method of choice for immobilization of this type of lesion was by the use of the Thomas splint, and skeletal traction from a pin through the tibial tuberosity or skin traction was applied.

Small wire loops are attached to the proximal and distal ends of the limbs of the splint, either by welding or by a few turns of a plaster-of-Paris bandage. The immobilized limb is suspended from these loops by cords leading through the lower wheels of a compound pulley, and the 'rocking action' which is obtained at this compound pulley allows the patient to assume the upright position with ease.

The method is illustrated diagrammatically in Fig 546.

We employ sliding traction from a tibial tuberosity pin as a routine measure, as it is effective and requires

no further adjusting after reduction has been secured. It has the further advantage of permitting a limited range of movement at the knee-joint, by virtue of the hinged joint of the knee-flexion-piece upon

maintained by means of plaster-of-Paris slings rather than calico or canvas, and these then required no further adjustments to prevent the posterior angulation which is so liable to occur with the latter

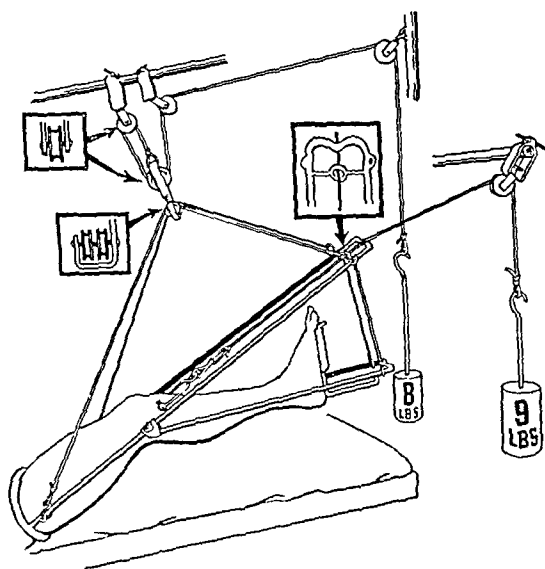


FIG 546 —Apparatus used in mid shaft femoral fractures. Sliding traction is employed, and inset shows metal loop at the distal end of the splint for guiding the traction cord and preventing alterations in direction of traction during the movements of the patient. Type of compound pulley used is also illustrated in insets.

which the leg is made to rest. On the other hand, when skin traction is applied, the Thomas splint itself is bent through about  $15^\circ$  at the level of the knee-joint, so that no knee movements are possible.

A guiding loop at the base of the splint, shown in inset in Fig 546, prevents alteration in the line of traction on the limb during movements of the patient, and he is therefore able to swing himself from side to side, as well as to stand upright in bed.

Fig 547 shows a photograph of a patient 'in action'.

It is realized that many surgeons prefer fixed traction as opposed to sliding, and this may be secured by one of two modifications.

The traction cord may be secured to the base of the Thomas splint and its tension adjusted daily in the usual manner. In this case, a small weight will suffice to ease the pressure of the ring of the splint on the ischial tuberosity and so prevent pressure sores at that site.

A more satisfactory method has, however, been used by us with effect, and it has the advantage of eliminating the need to perform daily adjustments of the tension on the traction cord. It is illustrated in Fig 548.

Accurate fitting of the ring of the splint is ensured in all cases, where necessary, by the insertion of a 'shell' dressing or firm pad of wool between the ring and the ischial tuberosity.

In compound fractures where accurate reduction of the fracture was secured under direct vision prior to delayed primary suture, the reduction was

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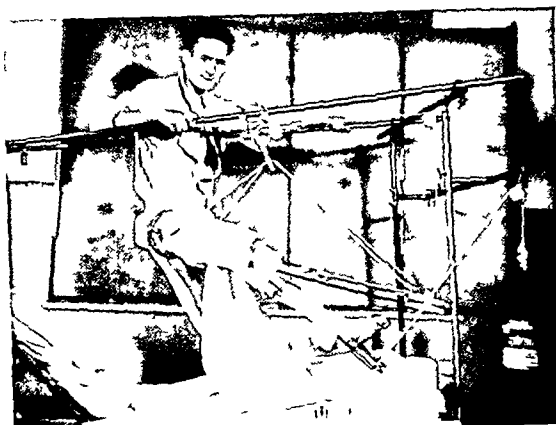


FIG 547 —Battle casualty (shell wound). Compound fracture of mid-shaft of right femur. The patient stands upright, without the direction of the traction being altered. Note: When the patient stands up the direction of traction of the suspending apparatus is in a headward direction, maintaining the apposition of the ring of the splint against the ischial tuberosity.

They were extremely well tolerated, and in no case were they responsible for the development of pressure sores. Posterior angulation, due to severe muscular wasting of the part, was not a serious factor in our series of cases, for the mobility of the patient militated in no uncertain measure against this wasting.

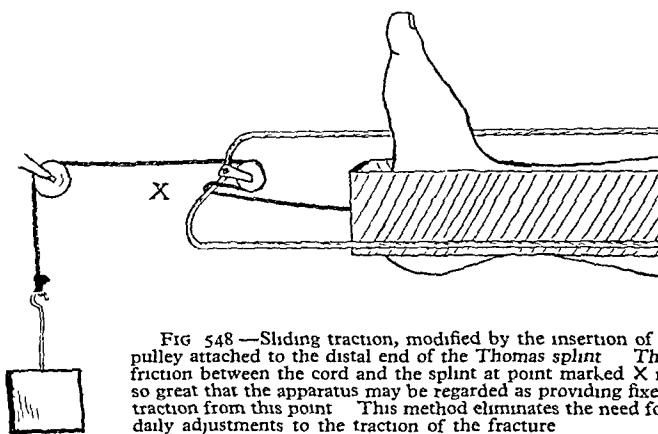


FIG 548 —Sliding traction, modified by the insertion of a pulley attached to the distal end of the Thomas splint. The friction between the cord and the splint at point marked X is so great that the apparatus may be regarded as providing fixed traction from this point. This method eliminates the need for daily adjustments to the traction of the fracture.

An unexpected finding in our series of cases was the extraordinary small weight which was required to maintain reduction of a fracture.

This can be accounted for by the fact that the degree of mobility of the patient is such that inertia at the pulley over which the traction weight acts is reduced to a minimum. We found that 9-11 lb was in the majority of cases sufficient to maintain reduction, and in one case we were able to demonstrate distraction of the fracture radiologically with only 11 lb.

### C SUPRACONDYLAR FRACTURES OF THE FEMUR

Supracondylar fractures of the femur are immobilized in a Thomas splint. Skeletal traction in the long axis of the limb is applied by the insertion of a Steinmann's pin through the tibial tuberosity, and this traction is of the fixed or sliding variety.

A second pin is inserted through the small distal fragment of the femur, and vertical traction applied to this pin to prevent posterior rotation of this

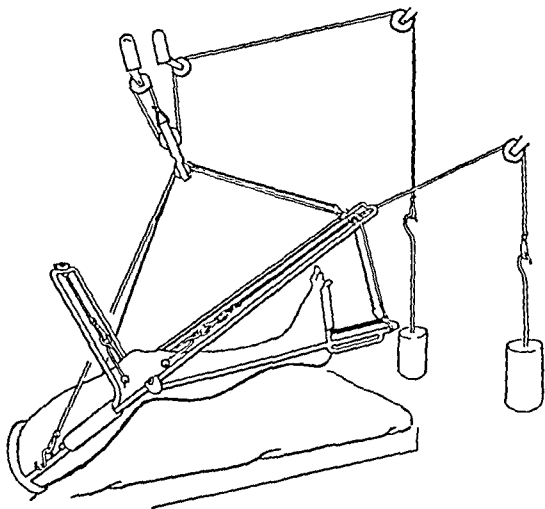


FIG 549—Apparatus used for supracondylar fractures of femur. An extra knee-flexion piece, bent to a right angle, is employed to provide vertical traction on the small distal fragment, while longitudinal traction is applied in the usual manner. The splint is suspended as for mid shaft fractures, and the patient enjoys the same degree of mobility in bed.

fragment. This traction is of the fixed variety, and is shown in diagrammatic form in Fig 549.

It is applied from the distal end of a knee-flexion piece bent to a right angle and attached to the bars of the Thomas splint at knee level by means of a few turns of a plaster-of-Paris bandage. A butterfly nut and bolt allow accurate reduction of the posterior angulation, and counter-traction is provided by firmly bandaging the limb to the Thomas splint in the usual manner.

The splinted limb is suspended in the same manner as above, and the patient enjoys the same freedom of movement.

This method of treatment is of particular value in compound fractures and in fractures which extend into the knee-joint, for it permits movements at this joint within a few days of immobilization, and allows ready access to the anterior aspect of the knee, so that the occurrence of 'adherent patella' may easily be averted.

Radiographic evidence of reduction of a supracondylar fracture of the femur by this method is shown in Fig 550.

### D COMPOUND FRACTURES INVOLVING THE KNEE-JOINT

These cases were usually due to gunshot or shrapnel wounds penetrating the knee-joint, and immobilization in a Thomas splint with skin traction was the rule.

The limb was then suspended in the same manner as above, and the patient afforded the same degree of mobility.

Cases in which penicillin-resistant organisms were obtained from the joint were found to require the more complete immobilization of a double-hip plaster-of-Paris spica, in order that the limb, if not the joint, might be saved, and they were suspended after the manner of fractures of the hip. It is significant that in no single case treated by this



FIG 550—Supracondylar fracture of the femur. Control radiograph shows reduction of the fracture by the use of a Thomas splint and double skeletal traction. The bars of the Thomas splint and of the two knee flexion pieces are shown, as also the Bohler's stirrups attached to Steinmann's pins.

manner was amputation of the limb required, and we feel certain that the promotion of the general health of the patient by this method of treatment was an important factor.

### E FRACTURES OF THE TIBIA AND FIBULA

Two types of fracture of the tibia and fibula are recognized—namely (1) Fractures in which reduction is stable, and in which no form of immobilization other than an adequate plaster-of-Paris cast is required. These include those cases in which bone-grafting or plating has been performed. (2) Fractures in which the reduction is unstable, and in which continuous traction is required for the initial period of treatment.

In the *stable fracture* an above-knee plaster-of-Paris cast is applied, and two wire loops are embedded in the cast during its application, at knee- and ankle-joint levels. The limb is suspended after the manner shown in Fig 551, and the usual triple-acting pulley employed.

Two advantages are apparent. In the first place, active leg-raising exercises are permitted from the day of the operation, and very soon the patient is able to do this without the assistance of the apparatus at all. Secondly, it permits the most effective elevation of the limb. This is of great value in reducing the œdema of the leg in cases of compound fractures and thereby enabling successful delayed

suture of a wound which would otherwise have required a skin-graft. As soon as local conditions permit, the patient is allowed to walk with the aid of crutches and without taking weight on the injured limb. The use of the apparatus described above contributes substantially towards accelerating this step.

In the unstable fracture, where internal fixation is contra-indicated, skeletal traction is applied by means of a Steinmann's pin through the lower end

calico sling is applied to the pelvis and the patient suspended in such a manner that the pelvis rests very lightly on the bed. A 'stop' is applied to the suspending weight, to prevent the patient lowering himself any farther on to the bed, but it does not prevent him from raising himself freely. Reduction of the fracture is maintained by the body-weight,

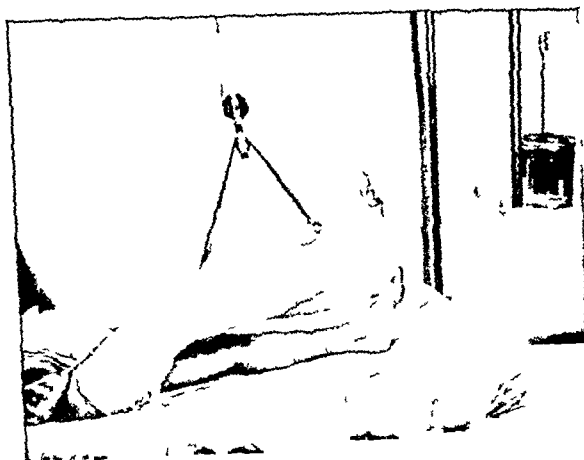


FIG 551 — Stable type of fracture of tibia and fibula. Wire loops are incorporated in the plaster cast, and the limb is suspended from these loops. Active exercises of the leg commence at once.

of the tibia and fibula, 1 in. above the ankle-joint, and the limb encased in an above-knee plaster-of-Paris cast, incorporating the pin.

A Thomas splint is then applied and the limb suspended after the manner of a fracture of the femur, described above.

Sliding traction is employed, and a weight of 8 lb. is found to be sufficient to prevent shortening in the majority of cases of compound fractures.

This method eliminates the use of the conventional Bohler-Braun type of splint and allows the patient maximum comfort as well as mobility. A diagrammatic representation of the apparatus is shown in Fig. 552.

## F FRACTURES OF THE PELVIS

Simple fractures of the pelvis present no problem. Reduction is effected by the Watson-Jones technique, and immobilization secured by means of the double-hip plaster-of-Paris spica. The patient is then suspended in the same manner as high fractures of the femur, and he enjoys the same degree of mobility.

Battle casualties, however, are often of a much more complicated nature. The fractures are compound and comminuted, and are frequently accompanied by lesions of the peritoneum, bladder, or urethra. It is therefore not always possible or desirable to apply an encircling plaster-of-Paris cast during the initial stages of treatment, and yet immobilization of the pelvis is essential to the comfort of the patient. In these cases we adopt one of three forms of treatment —

1. Where lateral compression of the pelvis is necessary to maintain reduction, a broad canvas or

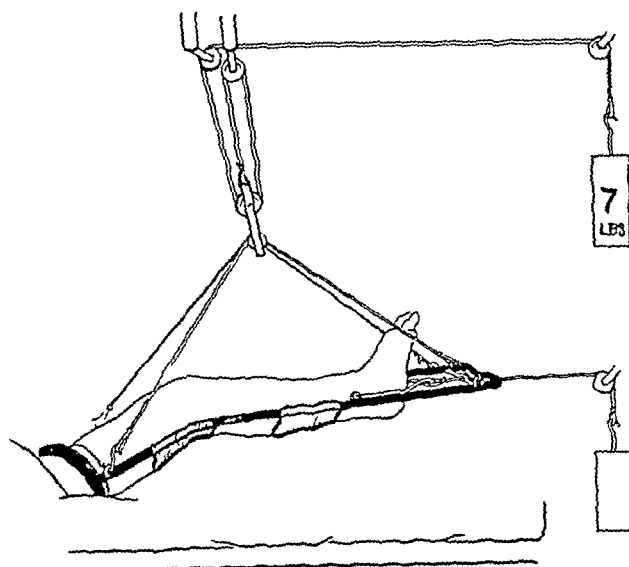


FIG 552 — Fracture of the tibia and fibula requiring continuous traction. A pin is inserted through the tibia above the ankle-joint and the limb encased in plaster-of-Paris. Sliding traction on a Thomas splint is applied, and the patient afforded maximum mobility by means of efficient suspension of the leg.

and there is ready access to wounds or drainage tubes in the anterior abdominal wall or in the perineum.

2. Where lateral compression of the pelvis is not required, the pelvis is immobilized in a plaster-of-Paris bed until such time as a hip spica may be applied. Suspension of the patient in the plaster bed is described in Section G below.

3. Fractures of the pelvis with concomitant destruction of the acetabulum require continuous traction to prevent upward dislocation of the hip-joint. This may be applied from a Steinmann's pin through the tibial tuberosity, and either a Thomas splint or a plaster hip spica, which incorporates the pin, is employed for immobilization.

## G FRACTURES AND DISEASES OF THE SPINE AND ADNEXÆ

Simple compression fractures of the spine and diseases which require immobilization in a plaster jacket require only a Balkan beam and a 'monkey chain' for adequate mobility in bed.

There are, however, the more severe cases which require to be immobilized in a full plaster bed, and it is with this type of case that we propose to deal in detail. They may be classified into two principal types: (1) Fractures of the spine with lesions of the spinal cord, and (2) Tuberculosis of the spine and the sacro-iliac and hip joints.

These cases are immobilized for the most prolonged periods, usually in a plaster bed which is mounted on a wooden or other type of frame. Three

serious disadvantages of this form of treatment are at once apparent, namely (a) The patient's view is limited to the ceiling or floor of the ward, and he 'vegetates' from sheer boredom (b) Drainage of

bed are shown. The apparatus appears complicated at first sight, owing to the number of cords and pulleys used, but it is emphasized that a single principle is applied throughout, and that the materials

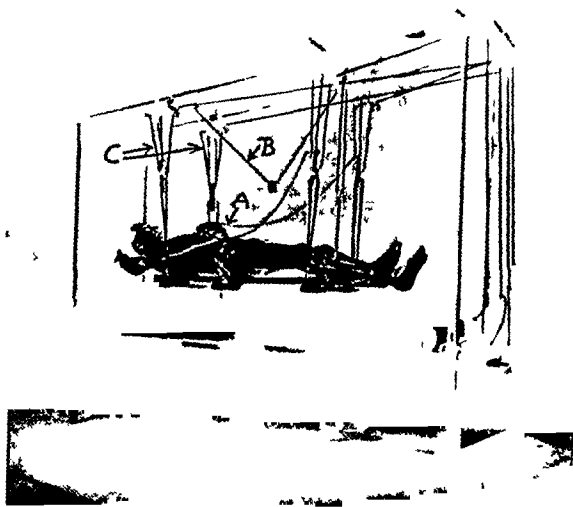


FIG 553—Tuberculosis of the lumbar spine treated in a plaster bed which is suspended. This form of suspension gives finger-tip control, and the patient is able to alter the position of the bed at will. The neutral or resting position is shown, and the patient is able to lower the bed on to the mattress.

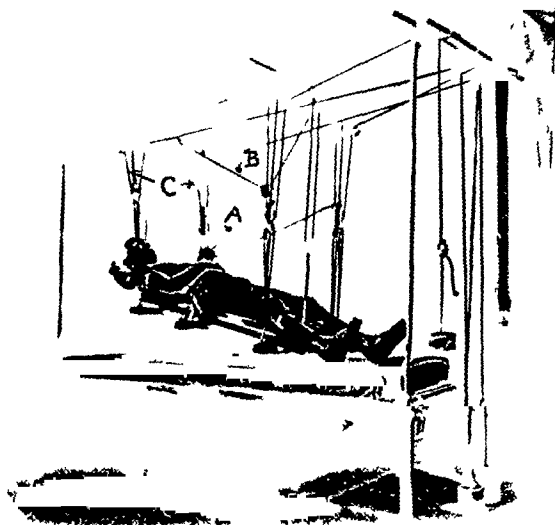


FIG 554—Case of tuberculosis of lumbar spine treated in a plaster bed. The patient has raised the head end of the bed. Traction on cord A lowers the foot end of the bed. Traction on cord B raises the foot end of the bed. Any desired position of the bed, once obtained, is maintained without further effort.

the renal pelves is poor, and there is a constant danger of the development of renal calculi (c) The vasomotor system becomes so sluggish that the ultimate assumption of the upright position is associated with excruciating pain in the feet and legs.

A method of treatment which minimizes the above three factors, without in any way interfering with the immobilization of the affected part, is therefore described below.

The standard posterior plaster bed or shell is used, with an anterior, turning bed or shell for use at regular intervals.

Wooden bars are incorporated in the under-surface of the plaster bed, two of them in a longitudinal direction to provide strength with a minimum of weight, and two in a transverse direction, at below-knee level and shoulder level, to furnish the necessary 'suspension points'. These bars are shown in Figs 553-555, and their dimensions are—

Longitudinal bars Approximately 6 ft  $\times$  2 in  $\times$  1  $\frac{1}{2}$  in

Transverse bars 2 ft  $\times$  2 in  $\times$  1  $\frac{1}{2}$  in

The principle of suspension is the same as that described above, but in order that maximum efficiency of the apparatus be obtained, the mechanical advantage of the pulley system is increased to four at shoulder level on both sides, while it remains at three at below-knee level.

This suspension allows the nursing staff to alter the position of the plaster bed with ease, while the addition of a further auxiliary system of pulleys enables the patient to perform these movements for himself.

The method is illustrated in the accompanying photographs, and the various positions of the plaster

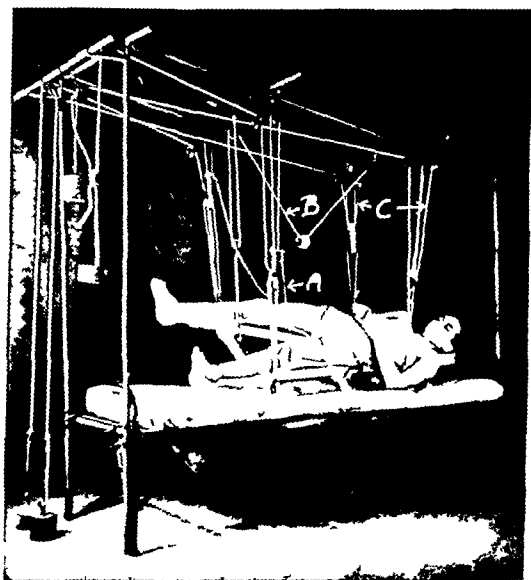


FIG 555—Tuberculosis of lumbar spine. Same case as in Figs 553-554. The patient has tilted the bed over to one side. This is done by pulling on cord C on both sides of the head end of the bed. The position shown promotes drainage of the renal pelvis and assists the patient during feeding.

required are no more than the standard equipment with which many orthopaedic units are supplied. Attention to detail is essential, and the weights are finely adjusted by the method of 'trial and error' until finger-tip control is provided for the patient.

The weights involved in the case of the patient shown in the illustrations were —

Body-weight of patient	105 lb
Weight of plaster cast	25 lb
Total	130 lb

Suspending weights —

2 × 11 lb at shoulder level, each with an M A of 4	88 lb
2 × 7 lb at below-knee level, with an M A of 3	42 lb
Total	130 lb

This plaster bed was so delicately adjusted that the addition or subtraction of a single blanket was sufficient to disturb the balance, but it gave the patient finger-tip control, and enabled him to adopt the various positions shown with absolute ease. He raised the head end of the bed for the purpose of reading, tilted it over to the side for eating and sleeping, and raised the foot merely for variety.

The effects on morale are considerable. The patient delights in the relative freedom of movement afforded him, and in the degree of independence he enjoys. He takes pride in the assistance he is able to give the nursing staff in the performance of their routine duties, such as arranging his bedclothes, administering bed-pans, etc., and he spends a good deal of his day in altering his position to suit his needs.

Arm exercises, renal drainage, and stimulation of the vasomotor system by alterations in posture are virtually automatic.

The anterior or turning shell is suspended in exactly the same manner as above, but in this case the auxiliary pulleys are dispensed with, for the patient raises or lowers the shell by merely grasping the bedstead.

Details of the apparatus are described and illustrated in Figs 553-555 below.

**Technique of Suspension** — In order to obtain maximum efficiency of the apparatus described above, attention to detail is essential, and the following points in technique require to be rigidly observed —

1 Pulleys should be mechanically efficient, and should have a diameter of 1½-2 in.

2 Pulleys to be kept well oiled at all times.

3 Pulleys to act in their correct axes, without the imposition of any lateral strain.

4 Cords used in suspension to be of such a type as to offer the minimum of friction at the pulley wheels. Woven cord of the 'window sash' variety is suitable, but twisted cord is inefficient and liable to fray and break as a result of the friction it causes. We have found steel cable, used in aircraft, to be best.

5 Twisting of the cord or cable is to be avoided during the assembly of the apparatus, for this adds considerably to the friction at the pulley wheels.

6 Weights for traction on fractured limbs must be of considerably less magnitude than those normally employed, in order to avoid distraction of the fragments. We found 11 lb to be adequate in most fractures of the femur and 8-9 lb in fractures of the tibia and fibula.

7 Wire loops incorporated in plaster casts must not encircle the part, but must be applied only to the upper half of the cast. This eliminates the danger

of their cutting into the cast and causing pressure sores.

8 Balkan beams must be of sufficient strength to support the weight of the patient at least three times over, for the exercises which he is apt to perform impose a great strain on the beams.

## ADVANTAGES OF THIS METHOD OF SUSPENSION

The initial object of this form of suspension was to mobilize the patient during the time that the affected part was immobilized.

This was achieved, but other advantages became apparent as treatment progressed, and in the case of fractures were such as substantially to reduce both the duration of treatment and of convalescence. The following were the outstanding features —

1 The patient is afforded maximal mobility in bed, coupled with entire comfort. The psychological appeal of the apparatus is such that no encouragement is needed to perform vigorous, active exercises, and it is no exaggeration to state that many patients emerge from their treatment in a better general physical state than existed at the time of receipt of injury.

2 The effect on morale is entirely beneficial. The patient enjoys an unexpected degree of independence from the outset of the treatment. The result in battle casualties is a conspicuous absence of that 'wounded soldier' complex which was so distressing a feature after the 1914-18 war.

3 The general health of the patient is enhanced by the strenuous exercises of all those muscles which are not immobilized.

4 Constipation, which can be so distressing to the patient who is compelled to remain in the supine position, is relieved by the effective abdominal contractions made possible.

5 Wasting of the muscles of the immobilized limb is minimized, and in several of our cases of femoral fracture we detected no wasting of the quadriceps group on ultimate removal of the Thomas splint or plaster cast.

The explanation of this phenomenon is probably that of Bohler, who emphasizes the value of the isometric, synergic contractions of the muscles of the immobilized limb, brought about by the active functioning of the muscles acting on joints which are not fixed.

6 The rate of union of fractures is accelerated. We attribute this to the absence or reduction of muscle wasting described above, for it is evident that the vascularity of a well-muscled limb is greater than that of a wasted one, *ipso facto* the vascularity of the fracture site is proportionately greater.

7 Joint stiffness after prolonged immobilization is reduced, and this is most evident in cases of femoral fractures. It appears that an important factor in this reduction is the excellence of the musculature of the part, and that the muscles are able to overcome minor adhesions directly movement is permitted at the joint. We noted a range of 90° of movement at the knee-joint in a large proportion of our cases of femoral fractures, and a rapid increase in this range during the first month of convalescence.

8 Post-operative pulmonary congestion is avoided by the immediate activity of the patient, and this complication has not occurred in a single case where this form of suspension has been applied. Our youngest patient was 6 years and our oldest 78 years of age. The latter patient suffered from congestive cardiac failure on admission to hospital, and operation was deferred until this had resolved.

9 Nursing is made extremely easy, for the patient is able to lift himself while bedclothes are adjusted, bed-pans administered, etc.

One nursing sister is therefore able to administer to an entire ward in a short space of time, and to perform her routine duties without effort. This is a factor of considerable value in an orthopædic ward, which is usually the busiest ward in a hospital.

10 Pressure sores are prevented by the patient's own movements, and by the ease with which the nursing staff are able to attend to the skin at danger points.

11 Postural drainage of compound fractures is performed by the movements of the patient, and 'sumping' of pus, which is so frequent a complication of fractures of the distal half of the femur, has not occurred in a single case treated by these methods. Should it be necessary, however, to turn the patient on to his face for postural drainage, this is readily performed by unhooking the slings from the compound pulley, turning the patient, and then re-attaching the apparatus in reverse.

12 Vasomotor tone of the lower extremities is maintained by the frequent alterations in position of the patient. This is of particular value in cases of tuberculosis of the spine, which are treated in a plaster bed for months or even years, and who are wont to suffer severe causalgic pains in the legs when the upright position is finally resumed.

13 Postural drainage of the renal pelvis is promoted, and the incidence of renal calculi in tuberculosis of the spine is minimized.

14 Effective elevation of an œdematous limb is permitted, and in the case of compound fracture of the tibia and fibula this may render possible the successful delayed primary suture of a hitherto unapposable wound. Early conversion of a compound fracture into a simple one is therefore facilitated.

In conclusion, there was no contra-indication to its use in our series of cases, and it was of value also in patients who did not have the use of their arms.

By raising or lowering the suspending weights the nursing staff were able to alter the position of the patient with ease and thus attend to his wants and needs.

### SUMMARY AND CONCLUSIONS

An improved method of balanced traction and suspension is described. The method is simple, and requires little more than is included in the standard equipment of orthopædic wards.

Its object is to afford the patient with a fracture or disease of the spine, pelvis, or lower extremities maximal mobility in bed, but it has several other advantages which are discussed.

It has been used in a large number of cases, and there has been no contra-indication to its use.

It is claimed for the method that it substantially increases the rate of union of fractures, and that it reduces the period of convalescence to a minimum.

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## THE SOLITARY ECTOPIC PELVIC KIDNEY WITH REPORTS OF TWO FURTHER CASES

By HOWARD G. HANLEY AND W. ARKLEY STEEL

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IN a most comprehensive review of the literature of solitary ectopic pelvic kidney, A. R. Stevens (1937) collected only 27 cases between the years 1830 and 1937. It is significant, however, that with improved diagnostic facilities, and doubtless the stimulus of Stevens's paper, 15 more cases have been recorded in the last ten years, bringing the total by

May, 1946, to 42. Therefore, although a solitary pelvic kidney is still a sufficiently rare anomaly to warrant publication, it probably occurs much more frequently than a reference to the literature would indicate. This fact is important, since apart from the 8 examples found at autopsy, the correct diagnosis was only established before, or without, operation

in 15 out of the remaining 34 cases, i.e., in only 44.4 per cent

Previous papers on this subject state that the incidence of solitary pelvic kidney is much greater in females than in males, but this is not so, since in the 29 cases where the sex is recorded, the ratio is only 15 to 14 in favour of the female

However, while only two of the male patients had associated genital anomalies, every one of the females recorded had some such lesion, and it cannot be stressed too often that the discovery of any serious genital defect, especially in the female, should be followed by a full urological investigation

A review of the numerous clinical histories shows that very few of the patients presented themselves as urological cases. The commonest symptom was lower abdominal pain, the commonest physical sign was a palpable tumour, while surprisingly few of them had any urological symptoms at all, so that the anomaly is of equal interest to both the general surgeon and the urologist

Many cases are undoubtedly overlooked, even after careful examination and/or laparotomy. Several of the published cases had been in hospital on previous occasions, while some had even undergone abdominal operations without revealing the true pathology. Appendicectomy was performed on at least three occasions, while the earlier reports show that the solitary kidney was removed twice, opened in mistake for the uterus once, and subjected to biopsy on another occasion. The mortality of the cases subjected to operation is very high, a point stressed by Lowsley (1944). The latter's own case is interesting in that he resected some 8 cm. of redundant ureter and reimplanted the remainder into the bladder, thus overcoming obstruction at the ureterovesical orifice. Wright (1945) performed a successful pyelocystotomy for a similar obstruction, while lithotomy has been performed on three occasions

As a rule, the blood-supply of a pelvic kidney comes from the region of the bifurcation of the aorta, and very adequate descriptions of the embryology and anatomy of such ectopic organs have been given by Fortune (1927), Gruenwald (1939), Anson et al (1942), and others, so that the purpose of this communication is merely to bring up to date the original tables of clinical data published by Stevens in 1937 and McCrea in 1942, and to record two further cases, one of which simulated acute appendicitis, while the other was complicated by a ureteric calculus (Table I)

**Case 1**—W. H., aged 43, attended the out-patient department giving a history of dysuria and hæmaturia of one month's duration. He complained that the pain appeared to be more in the penis than in the region of the bladder and stated that recently he had experienced increased frequency of micturition at night. On rectal examination the prostate itself was normal, but at the upper limit of the prostate there could be palpated a tender pedunculated swelling on the right side of the pelvis

He was admitted to hospital on Sept. 20, 1937, for investigation. Cystoscopy showed a slight inflammation present on the right side of the bladder, while a large pelvic swelling caused a bulge on the right side of the bladder, hiding the ureteric orifice from view. There

was no evidence of a left ureteric orifice. Following injection of indigocarmine, secretion was noted after six and a half minutes coming up from behind the bulge in the bladder

A plain radiograph showed no renal outlines, but there were several small dense opacities overlying the sacral area. Excretion urography (Fig. 556) showed no

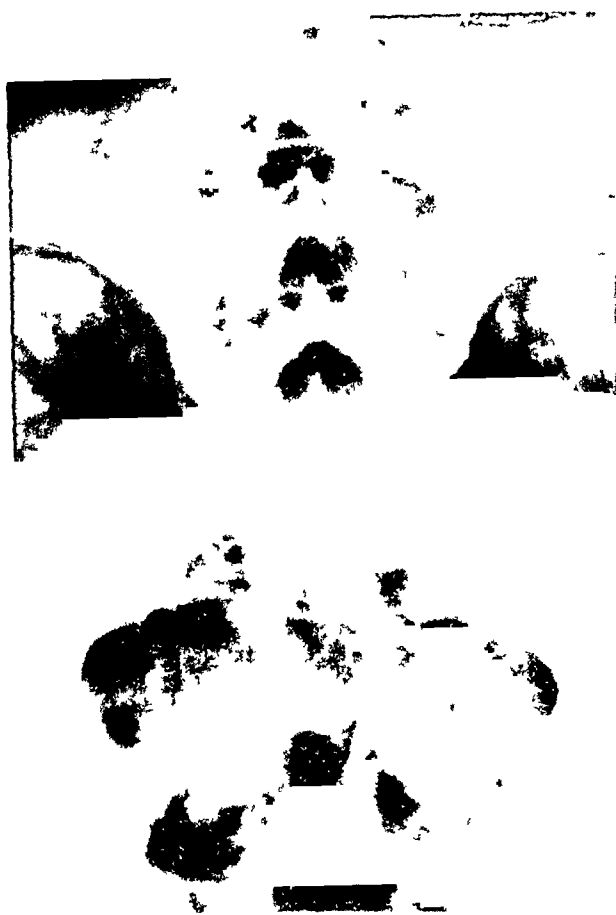


FIG. 556—Case 1. Excretion pyelogram showing calculus impacted at lower end of ureter

evidence of any renal tissue in either loin, but a solitary pelvic kidney was demonstrated in the presacral region. The function was good, while the shadows previously seen were located in the calices and in the lower end of the short dilated ureter. The blood-urea was 49 mg./100 ml. and the urea concentration test was within normal limits

Operation was carried out under spinal anaesthesia, and by a right paramedian incision and retroperitoneal approach the right kidney was found on the posterior wall of the pelvis. The ureter was extremely short and contained a mulberry-shaped stone about  $\frac{1}{2}$  in proximal to the bladder wall. This stone was removed. Both the ureter and kidney were covered with a mesh of blood-vessels, and no main renal artery could be seen or palpated

No attempt was made to remove the renal stones as it was felt that the viability of the kidney might be impaired by interfering with its vascular supply. The ureter was closed, and the abdominal wound closed with a tube down to the ureter

His convalescence was normal, apart from the fact that he complained of pain in the right groin. The wound healed satisfactorily, and he was discharged six weeks after operation



Table 1—CASES OF SOLITARY ECTOPIC PELVIC KIDNEY REPORTED IN THE LITERATURE  
*A Continuation of the Data given by Stevens (1937) and McCrea (1942)*

CASE No	AUTHOR	YEAR	AGE	SEX	ANOMALIES NOTED (GENITALS ETC)	CLINICAL DIAGNOSIS	UROLOGICAL FINDINGS	OPERATION	RESULT	BLOOD-SUPPLY
1	Henot	1830	8 mth		All genitalia absent Sex indefinite		Autopsy	Autopsy		Left renal artery from bifurcation of aorta, divided into two, entered upper pole of pelvic kidney
2	Merner	1854	47 yr			Carcinoma of left hypochondrium	Pelvic rounded kidney	Autopsy		Three arteries from aorta above bifurcation. Two from internal iliac. Ven from upper half of kidney to lower iliac, from lower half to common iliac
3	Watson, M	1864				Pathological specimen only	Dilated single ureter almost normal	Autopsy		
4	Hebb, R G	1885	6 yr				Ureter dilated elliptical	Autopsy	Died of uræmia due to parenchymatous nephritis	
5	Guelmi, A, and Gimelli, G	1887	10 yr	F	Uterus, broad ligament and ovary at 12th dorsal vertebra, vagina absent		Right solitary pelvic kidney of irregular shape	For atresia	Died 1 month after operation	Three renal arteries (1 right, 2 left) Two from left common iliac artery
6	Strube, G	1894	1 mth	M	Anovesical atresia					
7	Barlier and Broussole	1895					Dilated ureter	Autopsy	Died of anuria	
8	Chretien	1895			Vagina absent Fibromata in ovaries	Ovarian tumour		Removal of tumour and kidney	Died of anuria	
9	Buss	1899	21 yr	F		Abdominal tumour		Extirpation of kidney		
10	Winter, G J	1905	21 yr					Exploration operation		
11	Cullen, T S	1910	17 yr	F	Vagina absent Both tubes and ovaries in inguinal canals		Kidney contained a calculus Dilated ureter			
12	Cuore, G (cited by Tachot)	1910			Vagina and uterus absent Tubes and ovaries rudimentary			Exploration	Died of scarlet fever	
13	Gutschmann V I	1910	30 yr	F	Uterus bicornuate	Abdominal tumour	Dilated pelvis and calices Dilated ureter	Autopsy		
14	Rolleston, I D	1916	14 yr	M	Mentally defective	Ovarian cyst		Laparotomy		
16	Judd, E S, and Harrington, S W	1919			Malformation of liver and duodenum		Only one ureteral orifice	Laparotomy opened kidney for uterus	Living	
17	Judd, E S, and Harrington, S W	1919						Laparotomy		Kidney pelvis posterior to renal vessels pointing up and out ward
18	Day, R V	1924	20 yr	F	Vagina, uterus, left tube, and ovary absent			Laparotomy appendicectomy		
19	Roeder C A	1925		F	Vagina uterus, and left adnexa absent					

	Bitschal, J	1925	20 yr	Γ	Vagina absent		Only one ureteral orifice	No operation (clinical report)	Living	
20										
21	Bratrud, E	1929	48 yr	M		Appendicitis		No operation	Living	
22	Hennessey, R A	1929	19 yr	Γ	Never menstruated		Only one ureteral orifice, pyonephrosis	No operation	Died	One renal artery from bifurcation of aorta One renal vein enters bifurcation of vena cava
23	Lachot	1931	44 yr	Γ	Vagina absent Never menstruated	Renal calculus	Hydronephrosis with calculus	Transperitoneal lithotomy through kidney cortex	Urinary fistula Died 3 yr later of uræmia	No note of blood-vessels
24	Gutierrez, R	1933	32 yr	F	Hypothyroid Never menstruated Genital anomalies		Diagnosis by retrograde and intravenous pyelogram	No operation Renal lavage only		
25	Nesbit R M	1935	8 yr	M		Urinary retention	Large abdominal mass (liv- dronephrosis —1500 cc)	Nephrostomy	Living 9 years later	
26	Shpirt, M Y and Spectorova, Z G	1935			No information avail- able					
27	Stevens, A R	1936	31 yr	Γ	Rudimentary vagina	Abdominal and pel- vic mass	Right ureteral ridge and orifice only Pyelogram	No operation	Living	
28	Stevens, A R	1936	30 yr	M	No abnormalities	Calculus in pelvic kidney	Right ureteral ridge and orifice only Retrograde and intra- venous pyelograms	Lithotomy	Living and well 8 months later	
29	Kuzmenko, L N	1936			No information avail- able					
30	Houtappel, H C E M	1937	68 yr	M	No abnormalities	Calculus uretero- pelvic junction		Lithotomy	Died 5 days after operation	
31	Mayers, M M	1940	33 yr	M	No abnormalities	Pelvic kidney	Diagnosis by retrograde and intravenous pyelography	No operation		
32	Ogden, H C, and Maltry, E	1940	17 yr	F	Uterus, tubes, and ovaries displaced		Single left ureter	Exploratory	Living	
33	Ockerblad, N F, and Carlson, H E	1940	36 yr	F	Left tube and ovary congenitally absent Uterus oblong, pear- shape, shift to right	Solitary pelvic kid- ney	Diagnosis of solitary pelvic kidney made 6 years before by intravenous and retro- grade method	No operation	Died, renal failure, 6 years after dia- gnosis was estab- lished	
34	Planes, A, and Fablet, F J	1940			No information avail- able					
35	McCrea, L E	1942	33 yr	M	Undescended right testicle, epididymis lying in mesentery of cecum		Single right ureter	Autopsy	Died of uræmia	One artery at bifurca- tion of aorta, one artery from left com- mon iliac
36	Goldberg, H, and Fowler, H A	1942	51 yr	M	No abnormalities		No left ureteric orifice seen Excretion and retrograde pye- lograms Good drainage and function	No operation		
37	Weinstock, H L, and Keesal, S	1943	22 yr	M	No abnormalities	Renal tumour sus- pected, owing to protrude prematurn	No left ureteric orifice Excretion and retrograde pye- lograms Tubercle bacilli iso- lated from urine	No operation		
38	Lowley O S, and Henning, J H	1944	71 yr	M	Undescended tes- ticles No operative information		Ill-defined left half of trigone with no ureteric orifice Retrograde pyelogram showed poor drainage	Nephropey and excision of 8 cm of redund- ant ureter with implantation to bladder	Alive and well 15 months after oper- ation	

Table I—CASES OF SOLITARY ECTOPIC PELVIC KIDNEY—continued

CASE NO	AUTHOR	YEAR	AGE	SEX	ANOMALIES NOTED (GENITALS, ETC.)	CLINICAL DIAGNOSIS	UROLOGICAL FINDINGS	OPERATION	RESULT	BLOOD-SUPPLY
39	Nichols, B H, and Marr, J T	1945	20 yr	F	Uterus and tubes absent. Ovaries not identified. Normal but short vagina with no cervix	Pelvic kidney thought to be uterus	Excretion pyelogram showed no evidence of any left sided renal mass. Right kidney ectopic	Laparotomy	Alive and well 10 months after operation	From aorta round bifurcation
40	Wright, B W	1945	42 yr	M	Congenital deformed fingers. Absent right testicle	Hydronephrosis in solitary pelvic kidney	Excretion pyelogram showed no renal shadows and only a poor concentration of medium in bladder. Two normal ureteric orifices seen. No dye excretion from either orifice. Right blind ureter 3 cm. long. Left retrograde pyelogram performed	Pyelocystotomy performed		
41	Zucker, M O	1946	24 yr	M	No other congenital abnormality		Excretion pyelograms. Absent inter-ureteric ridge. No left orifice	No operation		
42	Goodhope, C D	1946	57 yr	M	No abnormality	Prostatic obstruction	Prostatic obstruction. Excretion pyelogram absent right kidney and pelvic left kidney. Right half of trigone absent	Attempted endoscopic resection. Suprapubic cystostomy	Died	
43	Hanley, H G, and Steel, W A	1947	43 yr	M	No abnormalities	Solitary pelvic kidney, ureteric stone	Excretion and retrograde pyelograms	Uretero-lithotomy	Alive and well a year later	From aorta round bifurcation
44	Hanley, H G, and Steel, W A	1947	9 yr	F	Absence of vagina, uterus, and tubes. Complete transposition of thoracic and abdominal viscera	Acute appendicitis with pelvic peritonitis	Excretion and retrograde pyelograms. Right half of trigone and ureteric orifice absent	Laparotomy	Alive and well 9 months later	Aorta and left common iliac artery

He was later seen in the out-patient department. In the six months following his operation he passed nine minute calculi. When last seen he was symptom free. Excretion urography on June 3, 1938, showed "Rather delayed excretion. Kidney still seen in presacral region. Not so dilated as previously. No calculi seen."

*Case 2*—A nine-year-old girl was admitted to hospital with a history of two days' abdominal pain and one attack of vomiting.

Examination revealed a flushed, but otherwise healthy-looking, child complaining of lower abdominal pain which had been colicky and intermittent, but was now dull and constant. Her temperature was 100.2° F, pulse-rate 120, while her tongue was slightly furred and she had not had a bowel action for 48 hours.

Both thighs were held slightly flexed for comfort, but she made no protest when they were passively extended. Her lower abdomen was markedly rigid and tender on palpation, while she indicated the site of maximum pain by placing her finger about three finger-breadths above the symphysis and to the right of the midline. Both loins were free from pain or tenderness and she denied any micturition symptoms. She had not yet started to menstruate.

Rectal examination revealed hard faeces and a vague mass high up in the pelvis which was too tender to define.

It was decided to operate upon the child as a case of acute appendicitis with pelvic peritonitis. During the routine examination of her chest a dextrocardia was discovered, but there was still no reason to doubt the diagnosis. Laparotomy was performed under gas, oxygen, and ether anaesthesia (administered by Dr T E D Beavan) when the true anatomical disposition became apparent. There was no free fluid. The caecum and a normal appendix were lying in the left iliac fossa, there being complete transposition of all viscera, while a large renal mass was lying over the right side of the sacrum, no kidneys being palpable in either renal fossa. There was no evidence of vagina, uterus, or Fallopian tubes, but two small masses palpable at about the site of the internal inguinal rings were assumed to be ovaries.

The renal mass was lying obliquely over the sacral region and there appeared to be at least three separate pulsating vessels arising from the area of the bifurcation of the aorta and the left common iliac artery. The kidney had less than half an inch of mobility in any direction.

The normal appendix was removed and the abdomen closed. Following the diagnosis of pyelitis in a solitary ectopic pelvic kidney, sulphathiazole was administered and a catheter specimen of urine two days later revealed a few colonies of coliform bacilli with a few pus cells in the centrifuged deposit.

The subsequent convalescence was uneventful until the fifteenth day, when she developed chicken-pox. As consequence of this, a full investigation was not carried out for another six weeks. By this time the child was symptomless and it was now just possible to feel the renal mass suprapubically, and quite easily per rectum.

Chest radiographs confirmed the dextrocardia, and a barium meal and follow-through confirmed the abdominal transposition. Excretion pyelograms showed a normally functioning ectopic pelvic kidney, but no loin shadows (Fig 557).

Cystoscopy revealed the absence of the right ureter and right half of the trigone, there being no inter-ureteric bar. A retrograde pyelogram was performed without difficulty (Fig 558). The blood-urea was 25 mg/100 cc and the blood-pressure 115/80.

The child is alive and well now nine months later, but the urine still contains a few coliform bacilli and pus cells in spite of chemotherapy.

## SUMMARY

A solitary pelvic ectopic kidney is probably not such a rare occurrence as was previously thought. Its importance lies in the fact that the symptoms

pyelogram absent left kidney Normal function of right pelvic kidney Absent left half of trigone  
 b Schreiber and Smith's case (1946)—Ectopic left pelvic kidney Absent vagina and uterus



FIG 557—Case 2 Excretion pyelogram



FIG 558—Case 2 Retrograde pyelogram

and signs do not generally indicate urological pathology, so that the correct diagnosis may only be made by a process of exclusion.

The incidence is probably equal in both sexes, but it cannot be too strongly emphasized that the discovery of any congenital lesion in the genital tract of the female should be followed by a full urological investigation. Every solitary ectopic kidney in a female so far reported has had an associated genital anomaly.

Two further cases are added to the world literature, bringing the total to 44.

Since this paper was presented for publication in November, 1946, it has been found that two more cases have been described—

a Howard B Mays's case (1946)—Male, aged 29, no genital abnormalities. Pelvic mass diagnosed as appendix abscess. Laparotomy. Intravenous

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## A SURVEY OF THE INCIDENCE OF INGUINAL HERNIA IN DIFFERENT RACIAL GROUPS

By A IAN L MAITLAND

THE projected regionalization of the hospital services throughout the country requires a knowledge of the prevalence of the commoner ailments in the general population if the assessment of the needs of each district is to be accurate. In this connexion, conscription for service in the armed forces offers an opportunity to inquire into the incidence of disabilities and disease in young adults. A survey of the records of a general hospital in an industrial area proves that inguinal hernia is a common cause of disability in the general population. In the Western Infirmary, Glasgow, during the years 1941, 1942, and 1943 this condition provided 4.64 per cent of the average annual totals of surgical admissions apart from orthopaedic cases, only being exceeded in frequency by acute appendicitis.

In this article the apparent incidence of hernia noted on investigation in a group of young adult males is discussed and related to the incidence disclosed in similar but smaller groups drawn from Allied countries. The investigation was carried out on personnel passing through a New Entry Establishment into the Royal Navy during twelve consecutive months. During the same period there were present in the Establishment comparable age groups drawn from three Allied countries. The opportunity thus afforded was taken to enlarge the investigation to cover these groups, which were drawn from Norwegian, Dutch, and Belgian personnel, as in all but one of the groups the medical standards applied prior to arrival were considered for practical purposes to be comparable.

British personnel passing through during the period consisted of new entries and ratings transferred from other establishments and training depots for re-categorization. For the purpose of this investigation only the new entries direct from civilian life have been considered. These had all been examined by civilian medical boards, and, on the standard applicable to such examinations, the discovery of a hernia did not bar the individual from service, but lowered his physical grade until repair had been effected. They were re-examined on arrival and men with scrotal abnormalities or scars referred to the surgical specialist. The personnel of the other national groups had all been examined prior to arrival. The Dutch group were examined in Holland or in London and by their own medical officers on joining the establishment. The Belgians had been examined either in London or before they left Belgium and were passed into the establishment by British medical officers. In the Norwegian group the medical examination was done in London but was not repeated as a routine on arrival. Most of this group came through Sweden and previous selection to a very high medical standard had probably occurred at that stage in their journey. The standard requirements in relation to hernia did not differ between groups or from those governing entry into the Royal Navy, and it was felt that with

the exception of the Norwegian group it was reasonable to assume that previous selection of a medical nature had little if any influence on the figures which subsequently emerged for each group.

The criteria required for inclusion as inguinal hernia were uncomplicated inguinal hernia, herniotomy scars, recurrent hernia, and hernia proved by operation as a complication of maldescent of the testis. Fusiform thickening of the cord in the canal, pain in the groin on exercise, and weakness of the posterior wall of the canal in subjects of lax musculature, were for simplification considered together under the heading 'weak canal'. It will thus be evident that the net was cast as widely as possible, and as the number of individuals who failed to disclose a scar or small hernia at the examination must have been small, the figures obtained can be regarded as reasonably accurate.

The largest group examined consisted of 20,454 recruits to the Royal Navy, almost all of whom were between the ages of 17 and 20 years. Since hernia is not a bar to acceptance for the service but must be repaired on entry, the incidence disclosed (5.36/1000) may be taken as representative for that section of the male population. It is of interest to record that the three cases classed as miscellaneous hernia were a symptomless diaphragmatic hernia apparently through a large opening in the posterior half of the left crus—first picked up by the radiologist on the miniature film of the pulmograph, an umbilical hernia, and an epigastric hernia.

The Royal Norwegian Naval Contingent was drawn from a wider age group than the British new entries, but consisted mainly of men under 25 years of age. During the twelve months under review just over 800 Norwegians passed through the establishment, and from this number only one case of pain in the groin was seen, although the course of training undertaken by this group was extremely severe. As a search of the records over eighteen months revealed only one herniotomy on a Norwegian rating, the total number passed through the Establishment in five years (2853) has been included. The incidence (2.8) is remarkably low and, as already noted, is regarded as probably due to previous selection to a high physical standard.

The Royal Netherlands Naval contingent totalled 2451 during the period, and consisted of two groups. One, the larger, was composed of young volunteers from liberated Holland, the other, much smaller, comprised returned prisoners of war who were, on the average, older. Their inclusion in the group, if it affects the figures at all, tends to lower the incidence (8.12). The factor common to both groups was that diet had been insufficient and exercise of a healthful nature reduced to a minimum during the period of the occupation. These men were examined medically before leaving Holland, and it is possible that a number of herniae were picked up there and did not reach Britain. Apart

from this possibility the incidence is relatively high, and, as will be shown later, is of particular interest.

The Section Belge in the Establishment recruited during the period 1350 new entries. They were all volunteers about 20 years of age, with a high average standard of education, who came over from Belgium after the liberation of the country. During the period of occupation conditions had been similar to those in Holland, except that the food situation—for these men at least—did not appear to have been so bad. The incidence (5.92) falls between that of the Dutch and British groups.

In Table I the numbers are arranged under wide headings, and in each group the incidence given is for inguinal hernia of all types. Incisional hernia has not been included. A study of this table shows

Table I

GROUP	INGUINAL HERNIA	FEMORAL HERNIA	MISCELLANEOUS	TOTAL	INCIDENCE PER 1000 INGUINAL HERNIA
British new entries, 20,454	110	1	3	114	5.36
Norwegian, 1940-45, 2853	8	—	—	8	2.8
Dutch new entries, 2461	20	—	—	20	8.12
Belgian new entries, 1350	8	1	—	9	5.92

that if these four groups are accepted as reasonably comparable, the divergencies displayed between them are not significant of themselves, but merely show tendencies in the groups as so far examined. When the groups are scrutinized more intimately and the figures for inguinal hernia dissected into their components, some further comparisons can be made. In Table II the results of this dissection are tabulated, and an examination of it reveals some interesting data.

Table II

GROUP	OBLIQUE INGUINAL HERNIA	MALDESCENT OF THE TESTIS AND INGUINAL HERNIA	DOUBLE HERNIA OBLIQUE AND DIRECT	RECURRENT HERNIA	DIRECT HERNIA	WEAK CANAL	PREVIOUS OPERATION	TOTAL
British 20,454	67	21	4	1	—	10	7	110
Norwegian 2853	4	—	—	—	—	6	1	8
Dutch 2461	5	—	1	1	6	7	—	20
Belgian 1350	4	—	Direct 1 Direct	—	—	1	2	8

The most striking difference which appears is the presence in the British group of 21 cases of mal-descent of the testis associated with oblique inguinal hernia proved at operation. This combination does not appear in any other group. It is of interest to note in passing, that, in the period reviewed, 49 cases of mal-descent of the testis were examined, of this number, 28 were submitted to operation as an associated hernia was suspected, confirmation being obtained in 21 cases. All the cases of mal-descent of the testis examined occurred in British

personnel, among whom there were observed as well, 3 cases of hydrocele of the cord which do not figure in the table.

The other information which emerges is the behaviour of the figures for uncomplicated inguinal hernia and those for direct hernia. An examination of the former shows that while the incidence for the British, Belgian, and Norwegian groups remains relatively the same at 2.35, 3.1, and 1.4 per 1000 respectively, that of the Dutch group drops sharply to 2.1. A survey of the latter shows, on the other hand, that direct hernia was not observed in British or Norwegian ratings, was noticed in 1 instance in the Belgian group, but was relatively frequent in the Dutch. When the figures for direct hernia are combined with those of 'weak canal' the difference between the groups is even more marked. This is done in Table III.

Table III

GROUP	DIRECT HERNIA	WEAK CANAL	TOTAL	INCIDENCE PER 1000
British, 20,454	—	10	10	.488
Norwegian, 2853	—	3	3	1.051
Belgian, 1350	1	1	2	1.481
Dutch, 2461	7	7	14	5.688

It is felt that the difference in incidence for this combination between the Dutch and the other groups as shown in this table, is a significant one on the figures alone, but there is a further disparity between them which is not so readily apparent.

In the British and Norwegian groups, the 13 cases regarded as having weak rings were, with two exceptions (both British), men who complained of pain on exercise, or had a fusiform thickening of the cord within the canal which would in time become an oblique hernia if it developed at all. The two exceptions showed laxity and slight bulging of the posterior wall of the canal on both sides, not sufficiently marked to be regarded as a direct hernia.

The single Belgian rating and all the Dutch ratings with 'weak canals' had more advanced bilateral bulging of the posterior walls, which was practically indistinguishable from direct hernia, but disappeared with the return to a generous diet and graded remedial exercises.

## DISCUSSION

The scant attention which the incidence of inguinal hernia in the population has attracted in the past is surprising, since it is the cause of so much

loss in economic efficiency in manual workers. In 1884 Berger, as a result of a survey of 10,000 hernias in France, estimated the frequency to be 1 to 14.9 in the male population, i.e., 62.8 per 1000. In 1936 Armentrout, in America, reported 1837 hernias in 37,472 examinations of working men, making an incidence of 49.5 per 1000. No reference to hernia could be found in either the British or American official medical histories of the Great War of 1914-18. During the lately-concluded hostilities there have been two references to date. Edwards, in 1943, gives the figure of 143 cases occurring among 1300 recruits to the Army from the 35-36 age group. These figures give the very high incidence of 110 per 1000, which suggests that they may be drawn from a group of low medical category. The tables published in the recent report of the Chief Medical Officer to the Ministry of Health (1946) show remarkably little variation in the different age groups of service patients and only a slight difference in the mean incidence for the age groups covering from 15 to 55 years between the years displayed (64.5 per 1000 in 1942, 59.25 per 1000 in 1943).

Hernia is more common in arduous occupations and no comparison is satisfactory unless the occupational factor is considered. The British series in this paper is drawn from young adult males in unreserved occupations, and it is possible that the reservation from conscription of the heavier industries may have affected the figures to some extent. Part, at least, of the wide variation between the figures for this series and the others quoted may be explained in this way, but as they bear a reasonable relationship to the figures from the other National groups in the survey, it seems unlikely that the inclusion of the industries excluded from conscription would raise the incidence by ten times. It is, however, possible that imponderable factors have had a greater influence on them than is apparent. The physical standards of the Royal Navy are known to be high, and among the citizens of a maritime nation it is general knowledge that a hernia is not a good thing to take to sea.

Consideration on these lines may have diverted an unknown number of the ruptured into the other Services and so lowered the figures obtainable by a survey of this nature by an incalculable amount. These figures are undoubtedly to the low side, but it is felt that when an accurate estimate of the incidence of hernia in the general population is available it will be found that the other figures quoted are too high.

The causes underlying the tendencies displayed by the national groups are interesting, but in the absence of further study must remain obscure. The occurrence of maldescent of the testis seems unlikely to have become an exclusive privilege of the British. If this is so, it sets a pretty problem for the student of heredity.

The variations may be explained in some measure by the differing impact of occupation on the nationals of the countries concerned. Sir Astley Cooper

(1827), in his excellent treatise on hernia, lists among the causes the combination of fluid food of poor quality and hard work, debility, and the rapid loss of weight in the obese. These are precisely the conditions which prevailed in the occupied countries for over four years. During the war of 1914-18 a 25 per cent increase in hernia due to lack of food was reported in Germany (Watson, 1938), and two papers were published in 1944 (Braine and Rudler, Giraud), the titles of which suggest that the same cause has produced an increase in hernia in France during the privations of the recent occupation. Unfortunately, these articles are not available for scrutiny in this country.

In Malta the prevalence of hernia was noted by Astley Cooper over a century ago and is still remarkable. During the recent siege there was an increase in hospital admissions for this condition, but Professor Debono (1946) ascribes this to living conditions in general and not to the diet alone, as the latter, although very restricted, rarely caused more than the loss of superficial fat. The factor responsible for the relatively high incidence of 'weak canal' and direct hernia in the Dutch is perhaps the heavy impact of the enemy occupations noted in Holland by Bulmer (1945). He states as his opinion that, apart from the occupants of concentration camps, the Dutch suffered a more severe restriction in diet than any other country in Western Europe.

I am indebted to the Medical Director-General of the Royal Navy for permission to publish this paper and to the Consultant in Medical Statistics, Royal Navy, for helpful suggestions during the preparation of it. My thanks are due to my colleagues in H.M.S. *Royal Arthur* for their assistance during the survey period. I must specially acknowledge the willing help and co-operation of the authorities in charge of the detachments of the Royal Netherlands Navy, the Royal Norwegian Navy, and the Section Belge during this time. Without their assistance much of the work would have been impossible. Lastly, I have to thank the Medical Superintendent, the Western Infirmary, Glasgow, for permission to use the records.

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## BONE ABSCESS FROM HUMAN BITE

### REPORT OF A CASE

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THE case recorded here is of interest as an instance of a bone abscess arising from a human bite. A search of the literature has not revealed another report of a similar case. In fact, it is notable that although before this last World War there were a number of cases published of human bite infections of soft tissue, since the beginning of this most vicious of all wars, in which the fiercest and most brutal hand-to-hand fighting has played a large part, no human bite infections seem to have been reported.

There are other points of interest which are noted in the course of discussion.

### CASE REPORT

Lieut A L S, aged 21 years

July, 1943 Bitten at the base of the right index finger by an enemy soldier in a hand-to-hand struggle during a commando raid. On return to his Base he was admitted to hospital with a swollen and badly infected hand. The bite was deep and the doctor told him at the time that the bone was bared and the soft parts badly torn. Hospital stay lasted fourteen days, but the hand was dressed for the last time two weeks after discharge as an in-patient. The wound healed well and function returned except full flexion at the metacarpophalangeal joint of the index finger, which was hindered by slight swelling over the palmar aspect of the metacarpal head. At times this became mildly painful and sometimes tender. He could not remember there ever being any colour changes or increase in size at these painful times. He proceeded on three weeks' leave as soon as the wound was closed, but was recalled after five days to rejoin for special training.

About the middle of August pain recommenced at the site of the wound and became severe. The part began to swell towards the end of the day, especially over the dorsum of the second metacarpal in the upper half. The patient continued at duty in spite of the pain, but by Sept 2 found work impossible because the swelling no longer receded at night, pain was constant, and the part was red and glossy. On examination the points which had attracted the patient's attention were confirmed, and in addition œdema of the whole of the dorsum of the hand was noted, most marked over the second metacarpal head. There appeared to be a small collection of pus forming and making its way surfacewards at a point 1 cm below the head of the metacarpal on the radio-palmar aspect. This aspect of the bone was exquisitely tender over its upper half. The patient's temperature was recorded as 101° F, pulse 100, respirations 20, general signs of toxæmia were present, a white blood-count showed a leucocytosis of 17,000, with 88 per cent polymorphs. The junior surgeon on duty incised the abscess, immobilized the hand in a posterior cast in flexion, and applied desiccated magnesium sulphate powder. Four days later the wound was clean and healing, the plaster cast was completed, and the patient allowed back to light duty.

On Sept 21 the wound was healed, and apart from tenderness over the site of the recent abscess all appeared to be in order. Function of the index was fair, exercises were prescribed. The laboratory report on the pus from the finger showed that the predominating organisms were hæmolytic staphylococci and large fusiform bacilli of the type found in Vincent infections. At this time nothing more was suspected than a residual abscess of the soft parts from infection carried in with the bite.

By Nov 7 the patient was back in hospital with a more diffuse swelling of the same region. The part was not so tender as before, but he complained that it ached more than the last time and kept him awake at night. No fluctuation or area of softening could be made out in the general and relatively firm œdema over the part. The temperature and pulse were within the limits of normal and the white count registered only 9000, with 75 per cent polymorphs. A radiograph (Fig 559) showed two



FIG 559—Radiograph showing two abscesses in the head of the second metacarpal immediately prior to operation

clear areas in the head of the bone towards the palmar aspect of its radial border, and corresponding to the clinically inflamed part. Considerable periosteal reaction was evident, but the joint space was clear of trouble. It was now apparent that there had been a bone abscess in formation for some time and that the small abscess draining superficially had been merely a throw-off from this or a small latent focus of infection lit up by its proximity to the forming deep bone abscess. In view of the extensive œdema around the part, the hand was again put in plaster in an effort to rest and settle the inflammation before attempting to expose the abscess. The area being small and in consequence the eventual exposure that might be obtained a limited one, it was felt that the œdema and inflammatory side-effects present at the time of operation should be minimal. The patient was much relieved by the plaster and the hand quietened down considerably.

On Jan 24, 1944, a radiograph showed the bone condition to be the same, and clinical examination revealed the œdema to be much less, deep tenderness was present over the upper half of the bone, and the total white count was found to have increased to 12,000. It was decided that the time had come for the bone abscess to be evacuated.

#### OPERATION (Jan 28)—

Preparation—For the two days prior to operation 4 g of sulphonamide were given daily. The hand was



bathed daily with soap and hot water, dried, and protected with a sterile towel. On the morning of Jan 28, one hour before operation, the hand was given a last bath, dried, put into a sterile white cotton glove, and the whole wrapped in two sterile towels. Morphine hydrochloride,



FIG 560—Radiograph of the hand taken at operation and before closure of the wound, confirming clearance of both abscesses and an intact joint above

Over the box a portion of a wooden sphere, 12 in in diameter and 2 in deep at the centre, was set. After elevation of the hand and adjustment of the tourniquet at correct pressure, the hand was spread over a sterile towel on the convex surface of the wooden support to give it a mild curve and stability. Adhesive tape over the fingers, together with another piece over the thumb, and both brought under the wooden stand, fixed the hand securely in position. The cotton glove was then painted liberally with mastisol. The arrangement of the towels was such that a narrow-folded one came under the palm and out over the thumb. Four towels were set in the usual square manner over the dorsum of the hand to isolate the area for operation.

*Anæsthesia*—Brachial plexus block anaesthesia was induced for me by Dr Victor Goldman.

*Exposure*—An incision was made extending along the radial border of the dorsal aspect of the 2nd metacarpal from 1 cm above the metacarpophalangeal joint to the same distance proximal to the base of the bone. The incision was placed over the muscular belly of the first dorsal interosseus and made slightly convex towards pollex to avoid subcutaneous nerves and the subcutaneous border of the bone. A few small veins exposed lying in the upper fatty layer of the superficial fascia were tied and divided. The deeper and definitely fascial layer of the superficial fascia was next incised in the line of the skin incision. A small transverse connecting artery from the second interosseus to the first was found, ligatured, and divided. The skin, with these two layers attached, forming the ulnar flap, was dissected up until the bone of the second metacarpal and the tendons of extensor communis digitorum and extensor indicis could be distinctly seen below the true deep fascia.

The deep fascial layer splits into two layers to enclose the extensor tendons at the radial edge of the extensor



A



B

FIG 561—The clinical appearance of the hand ten weeks after operation. A, Extension, B, Flexion—slight limitation

1 gr, with hyoscine hydrobromide,  $\frac{1}{100}$  gr, was given 45 minutes before the scheduled time and a pneumatic tourniquet placed in position ready for inflation. In the theatre the table for the hand had been arranged with an empty X-ray film box, the opening of which was away from the side where the surgeon would be working, so that a charged cassette could be easily inserted, withdrawn, and replaced if necessary during the operation.

communis tendon to index. By gentle manipulation the limit of this fascial space can be defined and the incision through the deep fascia so placed that the compartment containing the tendons is left intact.

In well-developed hands the deep layer of fascia can be incised apart from the delicate investing layer over the interosseus muscle below it. The incision was carried down to bone through periosteum near the radial

edge of the bony plateau forming the dorsum of the metacarpal

A small elevator was now introduced at the upper limit of the periosteal incision, just below the fibres of the joint capsule, and worked down towards the base, stripping that part of the first dorsal interosseus muscle from the bone. The elevator should be worked from head to base smoothly, exposure of the palmar surface being obtained by a series of such stripping actions—each at a more palmar (deeper) level than the last—until sufficient bone has been uncovered.

The radial flap consisting of skin, superficial fascia (with the veins, nerves, and first dorsal interosseus artery), deep fascia, investing layer, and muscle with attached periosteum, was then retracted easily to give a good view of the radial and palmar aspects of the affected metacarpal.

The periosteum over this end of the metacarpal was thick, oedematous, and peeled easily to uncover a layer of new bone, ribbed and pitted in characteristic manner. A trough was started with a fine mastoid gouge working towards the head of the bone and following the main mass of the new-bone formation. The lower abscess was quickly opened, and, after taking some of the contained brown pus for laboratory examination, was carefully cleared out with its walls.

With the wound well covered, an X-ray picture was now taken. The film showed that the lower abscess had been cleared but the second and upper one was still intact. On returning to the wound the mass of new bone was followed up where it turned on to the palmar surface. Excavation was carried out from below so that the bone close to the capsule of the joint was left intact. The radiograph showed how close the second abscess was to the joint, infection of which from careless opening of the capsule would result in a stiff index finger. A second radiograph now showed that the upper bone cavity had been widely opened and cleared, leaving the joint intact (Fig 560). The bone edges were trimmed and the periosteal flap with the muscle replaced over the bone. The skin was loosely sutured, the glove cut away, and a dressing applied. A posterior plaster cast was put on to hold the index in flexion at the metacarpophalangeal joint.

A temperature of 99° F, with a pulse of 80, was recorded during the first two post-operative days, but settled on the third day and did not return.

The skin sutures were removed on Feb. 6, the wound having healed *per primam*. The laboratory reported that a hæmolytic staphylococcus and a large, Gram-positive, fusiform bacillus had been isolated from the pus removed from the bone abscesses. Finger exercises at the interphalangeal joints were commenced on the second post-operative day. By March 17 finger movements were full, powerful, and equal to those of the left hand (Fig 561). He reported himself well and had been on full duty for a month by April 20.

I have seen this patient since on several occasions. He has been through severe fighting in Burma and has had no trouble with this hand.

## DISCUSSION

The story of this superficial abscess with pus containing the same organisms as the bone abscesses is interesting, raising the point of whether the original bite affected the bone or merely the superficial tissue above it. In the latter case the path of infection would appear to have been local spread to injured periosteum before an outlet through the palmar fascia was obtained and the abscess of September, 1943, appeared. The sequence in the history suggests a deep lesion involving periosteum and bone by the bite, and local abscess formation with partial

evacuation through the fascia and skin in September. Meantime, local spread under the periosteum to the bone by the unevacuated part of this abscess took place to culminate in its being shut off under the new bone formed, with consequent appearance of clinical signs in November, 1943. The fact that the original bite healed so easily is of interest in view of the after-history and type of infection found to be present.

The approach to the bone used here is a good one, making use of a natural route offered by the local anatomy. I have used this route many times in other lesions of the 2nd metacarpal and especially for bone-grafting in fractures. It gives good access, does not disturb the blood- or nerve-supply of the parts, and preserves the 1st interosseus muscle and the fascial space around the extensor tendons. In the powerful hands of manual workers and soldiers the superficial fascia is often found to consist of two layers—a superficial fatty layer directly under the skin and a deeper fibrous layer. This arrangement caused me much difficulty on earlier occasions, for the well-developed layer of the superficial fascia gave the illusion of having reached the true deep fascia. Confusion thus arose and much stripping up of the wrong fascial layer led to unnecessary destruction of the fascial space around the extensor tendons, and of the blood-vessels and nerves which are exposed by this mistake. Knowledge of the disposal of fascial layers and the use of the technique described will keep the surgeon from such confusion.

The point in technique of arranging for a cassette to be passed easily under the hand is an invaluable aid to operations upon these small long bones, especially where, as in this case, damage to the metacarpophalangeal joint has to be avoided at all costs. It is an arrangement well worth while in bone-grafting on these small bones, in open operations on the forearm bones, and in dealing with complex injuries involving the head of the radius, etc.

Management of a hand operation is always difficult, and many are the aseptic plans which go amiss through lack of forethought and attention to detail. The use of a wooden sphere as described gives the operator a hand to work on which is steady and easily controlled.

Use of a cotton glove with mastisol facilitates the application of towels and wound towels, again releasing the surgeon from another irritating feature of hand surgery upon which asepsis is frequently wrecked.

Care to avoid soiling the wound appears to have been responsible for primary healing here, and is well worth the trouble and more delicate manipulation required. No penicillin or sulphonamide was used. A set of Halsted mosquito forceps, fine-toothed and plain dissecting forceps, small retractors, small periosteal elevators, small mastoid chisels and gouge, and fine drills are an essential armamentarium for good hand surgery.

The value of carefully directed rehabilitation in the after-treatment of hands the subject of trauma, infection, or operation cannot be over emphasized. It is fortunately coming to be more and more realized that future function depends upon nothing so much as upon the correct use of this after-therapy.

## SUMMARY

1 A case of human bite which healed easily followed by a superficial abscess and later still by a bone abscess is reported

2 Both abscesses were infected by hæmolytic staphylococci and fusiform bacilli

3 Surgical approach to the 2nd metacarpal shaft from the dorsum through the space between the 1st interosseous and the tendon fascial compartment is described

4 The differentiation of a deep layer to the superficial fascia is described and the confusion it may cause with the true deep fascia is noted

5 The usefulness of an arrangement for taking radiographs during operation is noted and an easy method described

6 The use of a shaped wooden block for steadying the hand is described

7 Emphasis is laid upon rehabilitation after hand infections and injuries

## LIGATURE OF AORTIC ARCH IN THE NECK

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TWELVE cases of ligation of the aortic arch have been reported, all of which died. This would seem obvious, and therefore it is important to give the reasons for tying this vessel. The present report describes another of these accidents with the reasoning that led up to the operation. The other point of note is the presence of the aortic arch in the neck,

four minutes without producing unconsciousness or other signs of cerebral ischæmia. It had been noticed for several years, but had become more prominent recently

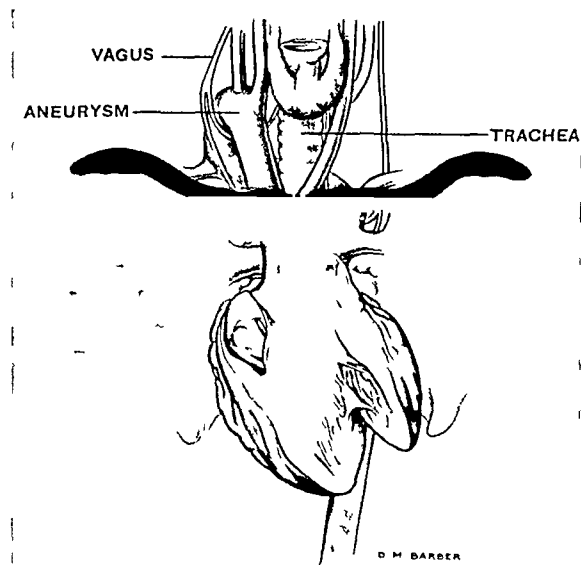


FIG 562—Sternum and clavicles superimposed on specimen

ascending to the cricoid cartilage, appearing clinically as an aneurysm. This is the first case of the kind reported and is of interest both clinically and embryologically.

## CASE REPORT

In March, 1943, we saw a girl of 9 with a pulsating swelling of the neck. Clinically it was an aneurysm of the right common carotid, producing a loud murmur and a thrill not transmitted upwards into its branches. On compression below, the aneurysm collapsed, the pulse slowed, and the face flushed. It could be compressed for

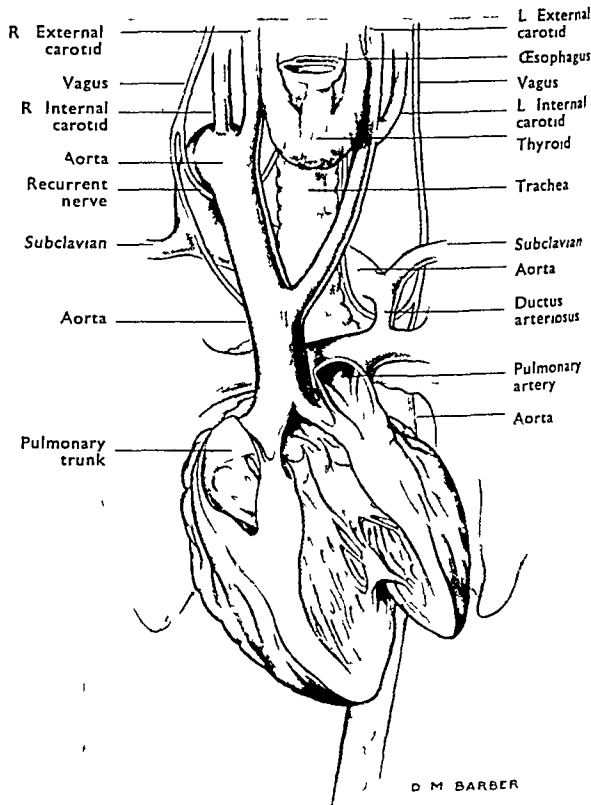


FIG 563—Post mortem specimen

Mantoux and Wasserman reactions were negative. A radiograph of the chest and neck showed no abnormality, except for the aortic knuckle, which might have been labelled 'small'. No cause for the aneurysm was found. Nine months later the aneurysm was larger, about the size of a pigeon's egg, immediately above the right sternoclavicular joint, with a peculiarly sinuous expansile

pulsation and a strong thrill not transmitted upwards into the external carotid. The trachea was pushed to the left, there was shortness of breath on exertion, and, particularly to be noted, slight dysphagia on extending the neck. The swelling became much more prominent on raising the chin, it could not now be compressed owing to the very strong pulse pressure. Something

recurrent laryngeal nerve curving around the dilated vessel. A rapid mental review of a very scanty repertoire of congenital anomalies was made, and it was decided that the aneurysm was one of the innominate arteries which had bulged upwards outside the thorax. There were no adhesions to surrounding structures, and the vessel was dissected out and tied as low as possible

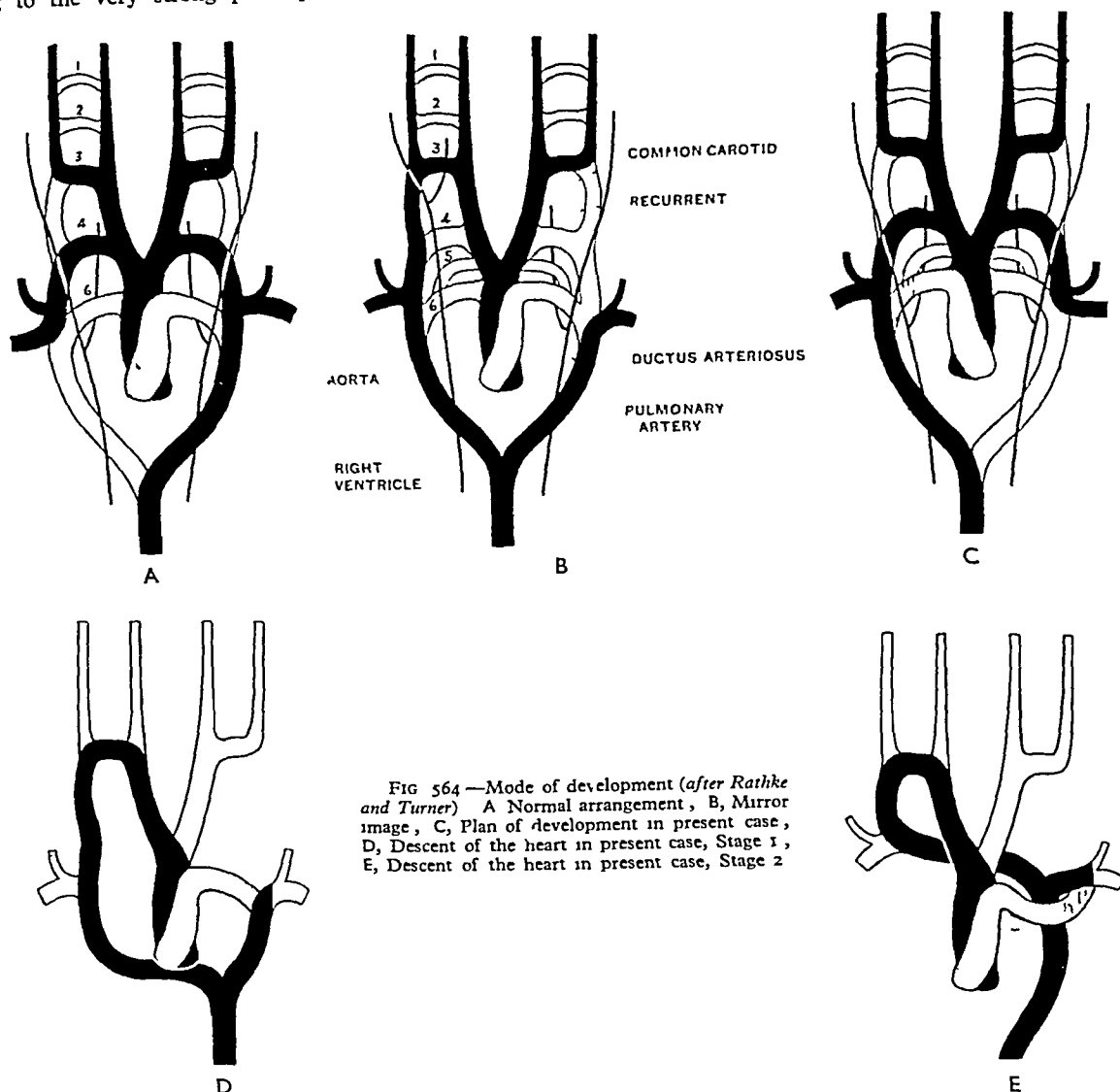


FIG 564—Mode of development (after Rathke and Turner) A Normal arrangement, B, Mirror image, C, Plan of development in present case, D, Descent of the heart in present case, Stage 1, E, Descent of the heart in present case, Stage 2

had to be done, as the symptoms were increasing, though not as yet urgent. Again a diagnosis of common carotid aneurysm was made (Fig 562).

The literature on aneurysm in children showed that a number were due to endocarditis and rheumatism, others to acute infectious diseases, syphilis, caseous glands, and trauma, in a surprisingly high number of cases no cause could be found (Bronson and Sutherland, 1918, Pilcher, 1937). Recently Tanner (1945) has described one of the right common iliac arteries which showed no evidence of cause. Aneurysms of the ascending aorta were sometimes due to coarctation beyond it, most of these aneurysms had ruptured.

**OPERATION**—In November, 1943, the neck was explored under general anaesthesia, through an oblique incision along the anterior border of the right sternomastoid. The swelling bulged out as soon as the deep fascia was incised, and rather surprisingly showed the

with a slip-knot, tightening the tape gradually. The aneurysm became much smaller, the right radial and carotid pulses stopped as expected, but no other untoward signs were noted, although the pulse-rate fell slightly. The left carotid was beating normally, five minutes later the ligature was released, and again tied with tape in two places. It was difficult to define the upper limit of the aneurysm, and reference to Fig 563 explains why this was so. No further dissection was therefore done, but the wound was closed and the child put on the ward trolley, suddenly, about fifteen minutes after applying the ligature, she started to bring up large quantities of frothy sputum, and percussion of the chest showed that the heart was enormously dilated to the left, extending into the axilla. Within a few seconds the child was dead of acute left-sided heart failure.

**AT AUTOPSY**—Fig 563 demonstrates the post-mortem findings. It shows that the aorta passes upwards and

to the right, into the neck up to the level of the thyroid, then backwards and downwards and to the left behind the œsophagus. It reaches a position corresponding to the normal beginning of the descending portion of the aorta, and on a postero-anterior radiograph reproduces the appearance of an aortic knuckle. From here on it follows the course of the normal descending aorta. The subclavian arteries take origin on each side from the downward-coursing portion of the arch, on the left side the subclavian is joined by a ductus arteriosus that is only just patent. There were two grooves on the ascending part of the arch, where the ligatures were placed. The heart was normal and not inverted.

## DISCUSSION

In most of its details the specimen corresponds to a right-sided aortic arch with persistent left root, of the type described by Arkin (1936). A very full description of this form of abnormality has been given by James W. Brown in his book, *Congenital Heart Disease* (1939). The one important detail that is new and not explained is the high position of the aortic arch.

An attempt is made to describe the anomalies by diagrams (Fig 564). Diagram A shows the normal arrangement, with the branchial arches outlined, the normal aorta derives from the persistent left fourth arch, the normal innominate from the persistent right fourth arch, and the subclavian arteries are almost entirely segmental.

Diagram B shows a mirror image of the first picture in complete *situs inversus*. A similar inversion of the great vessels may occur without inversion of the heart. In reptiles both dorsal aortæ persist.

Diagram C, when compared with the previous diagram B, shows three deviations: first, the disappearance of the right and left embryonic aortic arches, secondly, the persistence of the thoracic aorta on both sides instead of only on the right, and thirdly, the abnormally high position of the right functional aortic arch.

For the discovery of why the aortic arch is in the neck, I am indebted to Professor O'Donoghue, Professor of Zoology at Reading University. A study of the specimen showed that the two right carotid vessels arose independently from the aorta. This led to another reference to the diagram and a sudden realization that in this case the gill slit responsible for the arch is not the fourth but the third. Hence, there is no innominate artery, the recurrent laryngeal nerve takes its place under the persistent branchial vessel—namely, the third instead of the fourth.

Anomalies of these arteries due to variations of the third and fourth branchial vessels are infrequent, but have been described by various authors including Morgagni, Malacarne in 1784, and J. D. Boyd (1934). Among these are found the absence of the common carotid artery, the internal and external carotids taking origin directly from the arch of the aorta on one or both sides, embryologically such an anomaly would arise from the disappearance of the third

branchial artery and the persistence of a short portion of the dorsal aorta (ductus caroticus) which forms the beginning of the internal carotid.

The last two diagrams (D and E) explain how a relative slowing of growth of the left root (dorsal aorta) combined with the descent of the heart pulls the right descending aorta to the left, producing a vascular collar around the trachea and œsophagus, as in the present case. It is probable that it is the ductus arteriosus in foetal life, with its preponderating importance, that has something to do with this pull on the dorsal aorta. As a result of this shortening, the origin of the left subclavian is, in fact, the persistent remnant of the embryonic left thoracic aorta.

A few words as to the diagnosis on a future occasion. The slight dysphagia, noticeable only when drinking a glass to the bottom, should have led to a barium swallow, viewed laterally. A very characteristic notch is visible in cases of right-sided aorta with persistent left root, and presumably would have been seen in this case too (Rohan Williams, 1940). An œsophagoscopy would reveal the pulsating vessel, but the operation may be dangerous. Both before and during the operation it would have been found that compression of the cervical artery caused disappearance of the femoral pulses, but not of the left carotid. Later, if arteriography becomes easier and more practical, it may be possible to visualize such vessels by X rays, a similar anomaly on the left side has not been described, but is theoretically quite possible.

As to the correct treatment, our suggestion is that, as the upper outlet of the thorax becomes increasingly inadequate for both the ascending and descending aortæ, the first rib be removed on the side affected so as to give more space.

## SUMMARY

A case is described of an aortic arch ascending into the neck up to the level of the cricoid on the right side. An embryological explanation is given to account for this anomaly, and a description of the clinical signs and possible treatment is given.

I wish to thank Professor C. O'Donoghue for his brilliant inspiration in explaining the embryology.

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# GRANULOMA OF THE FALLOPIAN TUBE DUE TO SURGICAL GLOVE TALC

## SILICIOUS GRANULOMA

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SINCE Shattock first showed that silica in the subcutaneous tissues could elicit the slow formation of a granulomatous mass, it has come to be realized that the silicious talc used as a dusting powder could similarly lead to granulomatous lesions in the peritoneum. The danger of this substance, and also of lycopodium powder, is not yet widely enough appreciated, doubtless because of the frequently long interval between deposition and the obtrusion of the resultant granuloma into clinical notice. For the same reason it is probable that granulomatous lesions found in the Fallopian tube, described in the past as tuberculous, have similarly not been appreciated, in fact, as cases of foreign-body granulomata. The present study of granuloma due to the presence of talc contains 5 cases with lesions of the Fallopian tube.

### HISTORICAL REVIEW

Shattock (1916) gave the first example of a foreign-body granuloma due to silicious particles and called the lesion pseudo-silicoticum. He had previously urged the retention of the term pseudo-tuberculosis to indicate a non-infective granulomatous lesion characterized by a nodular appearance similar to tuberculosis with histologically a follicular arrangement of giant cells. A man developed a small tumour at the site of an injury to his lip 11 years previously. Histologically the lesion was characterized by a follicular arrangement of giant cells closely simulating tuberculosis, but examination by appropriate methods showed that the follicular arrangement was in relation to small refractile bodies believed to be silica.

Faulds (1935) described two further cases of pseudo-tuberculoma silicoticum, the lesions being removed 10 and 23 years after injury. The histological features of these cases were practically identical with that originally described by Shattock. Faulds achieved the absolute geological proof of the silicious nature of the foreign bodies present and, in addition, was able to demonstrate that they were identical with slate present on the ground where the original accident had occurred. A similar traumatic case was reported by Eden and Herbert-Burns (1936).

Antopol (1933) described 6 cases of foreign-body granulomata at various sites following operation and he identified in the lesions spores of lycopodium which he considered to be the causal irritant. In one instance (Case 4) following cholecystectomy he found small granulomata scattered over the whole peritoneal surface, but no mention is made of the state of the Fallopian tubes. He also reported a further case (Case 7) of a man who had undergone two previous abdominal operations. Subsequently the appendix was removed and Antopol found

granulomata in the subserosa, which contained small refractile bodies "morphologically identical with talc". He did not, however, note the similarity of the lesions to the pseudotuberculoma silicoticum of Shattock.

Erb (1935) described a further 6 cases of granulomata in various sites subsequent to operation. He also demonstrated spores of lycopodium in the lesion and considered this the causal irritant. He was, however, aware that the dusting powder used at the original operation was a mixture of lycopodium spores and talcum powder, but does not appear to have appreciated the irritant qualities of talc and made no search for it in the granulomata.

Feinberg (1937) and Gardner (1937) described cases of foreign-body granuloma due to talc in the scars of previous operation. Gardner emphasized the similarity to tuberculosis and German (1940) reported a further case as a lupoid sarcoid reaction due to talc.

McCormick and Ramsey (1941) recorded widespread intraperitoneal formation of talc granulomata following a number of diverse abdominal operations. Ramsey (1942) described a number of further examples in which lesions were found in the pelvis, but he noted no abnormality in the Fallopian tubes although two of his cases underwent bilateral salpingectomy.

German (1943) reviewed 50 cases of talc granuloma following laparotomy. The majority of the lesions he described were in the omentum and peritoneum, but he also found granulomata in the ovaries. He makes no mention of involvement of Fallopian tubes. In endeavouring to establish the relationship between the deposition of talc in the peritoneal cavity and the formation of granuloma, he showed experimentally that in the absence of trauma the talc particles migrated widely before lodging and setting up a reaction. He did not notice any preponderance of the lesion in the pelvis.

A number of investigators—Jones and Rouse (1914), Cappell (1930), and Thomas (1936)—have studied the disposal of various foreign bodies introduced experimentally into the peritoneal cavity, but have not noted any lodgement in the Fallopian tubes in the animals with which they were working.

Seelg (1943) and his co-workers carried out an experimental investigation of the role of talc, stressing the importance of talc introduced at operation as a cause of granuloma and peritoneal adhesions. They also sought a substance suitable as a dusting powder without the irritant effects of lycopodium or talc and which could be used as a dusting powder for rubber gloves. They decided that potassium bitartrate was the most suitable substitute for talc, since it was soluble and was absorbed without eliciting any reaction.

The only site other than the subcutaneous tissue, operation wounds, and the peritoneum, in which the relationship of silica and granulomatous formation has been reported, is the submucosa of the stomach, this was found by Cohn et al (1941) in a patient who had been taking aluminium silicate (kaolin) for years as an antacid

'Pseudo-tuberculoma silicoticum', suggested by Shattock, has the merit of indicating both the causal irritant, silica, and the morphology, which till then was, and even yet is, confused with that of tuberculosis. More recently the term 'talc granuloma' has come into use in America. In the present series it is presumed that the aetiological silicious matter is in fact talc, but it is proposed to use the term 'silicious granuloma'

### CASE REPORTS

The 7 cases in this series of granuloma due to talc as foreign body all had a previous operation during which one must presume the irritant material was introduced. In 2 cases the resultant lesion occurred in the scar in the abdominal wall, in the other 5 granuloma developed in the Fallopian tubes.

In all cases in this series a thorough search was made for acid-fast bacilli in sections stained by the Ziehl-Neelsen method and none was found.

### GRANULOMATA IN OPERATION WOUNDS

*Case 1*—C S, 1213/42, aged 30 Housewife. Admitted Nov 19, 1942

#### HISTORY—

*General* Swelling of appendicectomy scar and some pain on exertion appeared 12 years after a successful appendicectomy.

*Obstetric* Married 8 years, nulliparous.

EXAMINATION showed a large nodular mass in the scar, but otherwise no abnormality was noted.

Nov 23 Scar excised.

**PATHOLOGY**—A large irregular mass of tissue measuring  $3 \times 3 \times 7$  cm is seen running the whole length of the scar. The gross features of the specimen are similar in many respects to a keloid, on section it presents a distinctly nodular appearance. Histological examination shows the mass to be composed of multiple follicles containing giant and endothelioid cells (Fig 565). Examination with the polarizing microscope reveals numerous small anisotropic particles intimately related to the giant cells which in the main are grouped around them. The majority of the particles are small and spicular (Fig 566), but there is considerable variation in size and shape.

*Case 2*—488/43, male, aged 34. Admitted April 30, 1943.

**HISTORY**—Swelling of appendicectomy scar and some pain on exertion appeared 11 years after a successful appendicectomy.

EXAMINATION revealed a large irregular mass measuring  $2 \times 3 \times 8$  cm distending the scar.

April 30 Excision of scar.

**PATHOLOGY**—Both the macroscopical and histological features of the mass are virtually identical with those described in *Case 1*.

**SUMMARY**—The histological picture of both these cases is identical with the subcutaneous traumatic form of pseudo-tuberculoma silicoticum described by Shattock and Faulds, in both it seems highly probable that the silicious matter is talc and that it was introduced at the original operation.

### GRANULOMATA IN FALLOPIAN TUBES

*Case 3*—B McG, 656/41, aged 28 Laundry worker.

Admitted Aug 19, 1941, complaining of pain in the left iliac fossa of several weeks' duration.

#### HISTORY—

*General* The patient had an appendicectomy two years previously, but otherwise health had been good. Recently she has been suffering from pain in the left iliac fossa.

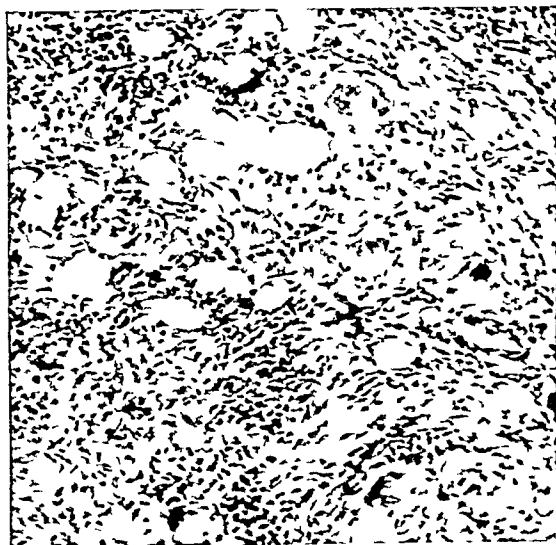


FIG 565—*Case 1* Nodule from surgical abdominal scar eleven years after appendicectomy. This somewhat follicular granuloma shows the characteristic giant-cell tissue and fibrous reaction (H and E) ( $\times 150$ ).

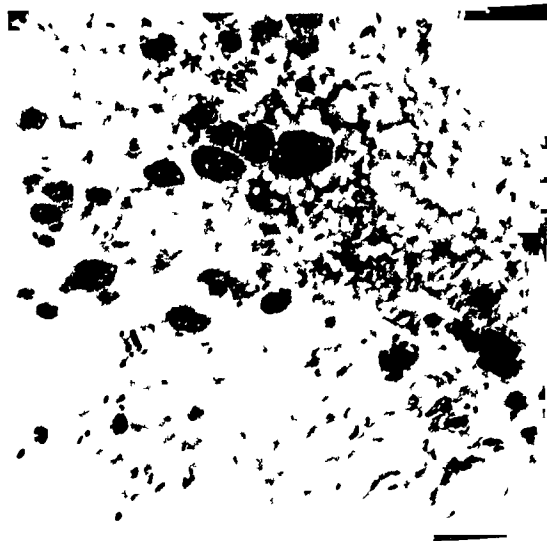


FIG 566—*Case 1* The same field as in Fig 565 taken through polaroid screens. This shows numerous anisotropic foreign bodies closely related to the giant cells. Some of the particles are definitely spicular (see Fig 572) (H and E) ( $\times 150$ ).

*Obstetric* Para 1, 6 years ago NFT Normal puerperium No further pregnancies  
*Menstrual* FMP 16 years, LMP Jan 24, 1941  
 Cycle 7-10/28, regular

ON EXAMINATION —

*General* Slight tenderness in left iliac fossa  
*Vaginal* Marked pain and tenderness in both left and right fornices

Aug 28 Bilateral salpingectomy performed Convalescence uneventful

**PATHOLOGY**—Both Fallopian tubes are considerably thickened but otherwise no features of note are seen on naked-eye examination Histological examination shows gross abnormality of the mucosal villi which are thickened and in many places fused together thus considerably reducing the lumen of the tubes (Figs 567, 568)

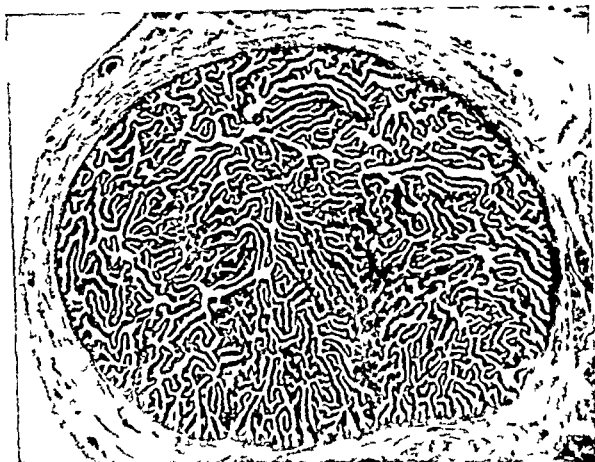


FIG 567—Normal Fallopian tube, ampullary portion The characteristically delicate villous structure is clearly seen (H and E) ( $\times 12$ )

Numerous follicles containing large Langhans-type giant cells are present throughout the swollen villi These occur mainly in follicles centred around small crystalline particles A few endothelioid cells are also present, but in the main these are scanty A dense infiltration with lymphocytes is present around the follicles Examination with the polarizing microscope reveals numerous small anisotropic particles intimately related to the giant cells and in many cases contained within them

While the failure to find tubercle bacilli does not exclude tuberculosis, the combination of the histological finding of doubly-refractile particles and giant cells in follicular systems, and the fact of a previous laparotomy, suggests that this is probably a foreign-body granuloma

*Case 4*—E T, 1256/45, aged 32 Housewife Admitted Oct 17, 1945, complaining of sterility

**HISTORY**—

*General* The patient had rheumatic fever in 1926 and acute appendicitis in 1928 Recovery from appendectomy was rapid and since then she has been in good health An enlarged gland, stated to have been tuberculous, was removed from her neck in 1943

*Menstrual* FMP 14 years, LMP Oct 13, 1945 (4 days before admission) Cycle 5/28, regular No discharge or dysmenorrhœa

*Obstetric* Married 9 years Nulliparous

**ON EXAMINATION**—

*General* Reveals nothing of note

*Vaginal* Vulva and cervix normal Slight tenderness in left lateral fornix with enlarged and thickened Fallopian tube

**OPERATION** (Oct 20)—Bilateral salpingectomy  
**PATHOLOGY**—Both Fallopian tubes are considerably thickened but otherwise show no gross abnormality Histological examination shows great thickening of the mucosa and matting of the villi Multiple follicles containing giant cells and anisotropic foreign bodies are present throughout The histological features are closely similar to those in the previous case

*Case 5*—J M P, 371/46, aged 35 Housewife Admitted March 15, 1946, complaining of a feeling of weight in the lower abdomen

**HISTORY**—

*General* The patient had an appendicectomy about 10 years ago and has been in excellent health till 6 months ago when she began to experience slight lower abdominal discomfort with some pain and a feeling of heaviness coming on at any time and unrelated to menstruation

*Menstrual* FMP 14 years, LMP, Feb 24, 1946 Cycle irregular, 5-6/19-23

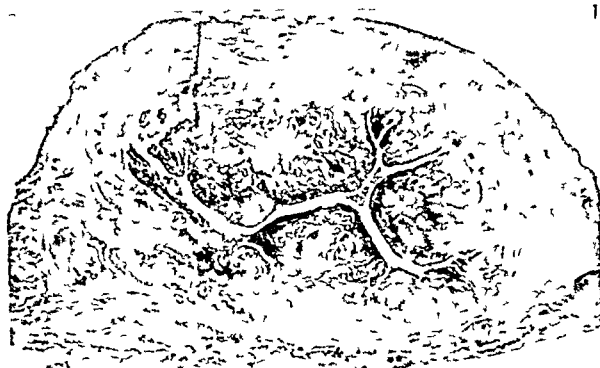


FIG 568—*Case 5* Fallopian tube The normal structure of the mucosa is destroyed The villi are submerged in the granulomatous masses (H and E) ( $\times 9$ )

*Obstetric* Married 9 years Nulliparous

**ON EXAMINATION**—

*General* Reveals no abnormality

*Vaginal* There is a large firm mass attached to the uterus, considered to be a subserous fibroid

**AT OPERATION** (March 10)—Myomectomy and left salpingo-oophorectomy (There is, unfortunately, no note of the appearance of the right Fallopian tube as seen at operation)

Convalescence was uneventful

**PATHOLOGY**—The Fallopian tube shows a moderate degree of thickening, being about 1.5 cm in diameter The fimbriated end of the tube is adherent to an apparently normal ovary The serous coat covering the tube seems thickened, but there is no suggestion of sub-peritoneal tuberculous nodules

The histological features are similar to those seen in the two previous cases The mucosa is thickened and the papillary processes are grossly distorted and destroyed (Fig 568), in them are numerous giant-cell follicles containing doubly refracting particles At two points lymphatics in the muscular coat of the tube are seen to contain a cellular mass consisting mainly of lymphocytes, these masses show central necrosis, but there is little evidence of cellular reaction around the lymphatics and no giant cells are present in this region Histological examination for foreign bodies and for tubercle bacilli in this area have both proved unsuccessful Since there is a large amount of silica present elsewhere in the section, it may be suggested that the necrosis of the cellular exudate in the lymphatics is due to the action of soluble or gel-form silica



The ovary presents no abnormality, showing normal maturation of Graafian follicles, and a large well-formed corpus luteum, evidence of recent ovulation

*Case 6*—M Y, 58/46, aged 26 Housewife Admitted Jan 3, 1946, complaining of post-menstrual pain during the last four months

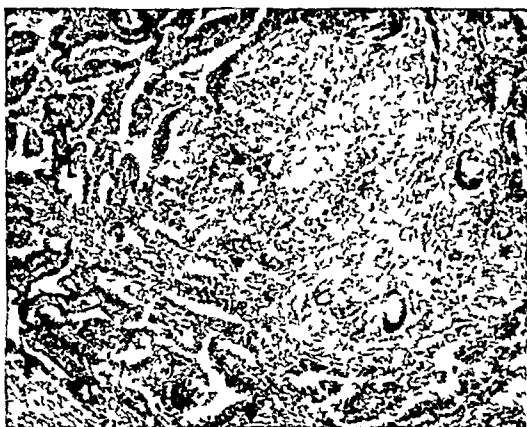


FIG 569—*Case 6* Fallopian tube This shows to the right the granuloma with its giant cells and somewhat follicular arrangement, to the left the villous structure is still obvious (H and E) ( $\times 36$ )



FIG 570—*Case 6* Fallopian tube This zone contains several giant cells with surrounding lymphocytes The wall of the tube is seen below (H and E) ( $\times 150$ )

#### HISTORY—

*General* The patient had an appendicectomy 8 years ago The abdominal wound discharged for some time and healing was slow, but otherwise convalescence was normal

During the past 4 months the patient experienced fairly severe pain following menstruation On each occasion this lasted about one week

*Menstrual* F M P 13 years, L M P Dec 6, 1945 Cycle 5/28, regular No discharge or dysmenorrhœa

*Obstetric* Married 6 years Nulliparous  
ON EXAMINATION—

*General* The patient is a well-nourished young woman and no gross abnormality is noted

*Vaginal* Thickened masses felt in both right and left fornices are considered to be tubo-ovarian in origin

*OPERATION* (Jan 6, 1946)—Bilateral salpingo-oophorectomy

*PATHOLOGY*—On each side the Fallopian tube is firmly adherent to the ovary by a thick layer of fibrous tissue, the whole forming an oval mass approximately  $7 \times 4 \times 3$  cm In neither of these swellings could the normal anatomical features be made out

Histological examination shows no very gross abnormality in the ovary underneath the encasing sheet of fibrous tissue There is evidence of ovulation and maturation of the Graafian follicles The Fallopian tubes and all the structures of the parovarium are closely bound to the ovaries by very dense fibrous tissue The tubes show gross alteration of their architecture, the villi are considerably thickened and show dense infiltration with chronic inflammatory cells, mainly lymphocytes In addition, there are numerous follicles, with large giant cells (Fig 569), situated mainly in the deeper layers of the mucosa adjacent to the muscular coat Closely related to, and in many instances actually contained within the giant cells, are irregular particles mostly of a yellowish brown colour varying in size from 3 to  $15\mu$  in diameter Examination with the polarizing microscope reveals that these particles are doubly refracting (Figs 570, 571) This case differs from the previous three, not only in the presence of bilateral tubo-ovarian fibrous adhesions, but



FIG 571—*Case 6* Fallopian tube This shows the same field as the previous section through polaroid screens The foreign body recognizable in the previous section is seen to be doubly refractive The smaller anisotropic articles are of the type that in practice one finds by polarized light and confirms by ordinary light as being intracellular (H and E) ( $\times 150$ )

also in having had a post-operative infection after her appendicectomy and it seems not unreasonable to relate these, certainly the silicotic granulomatous reaction is confined to the tube and absent from the ovarian region One has to presume that the ostium stayed patent enough to allow the entrance of the silica!

**Case 7**—N M, 344/46, aged 30 years Housewife  
The patient was admitted on March 5, 1946, complaining of lower right abdominal pain of three weeks' duration

# HISTORY—

**General** Eleven years ago the patient had an appendectomy for acute appendicitis. There was no evidence of peritonitis at the operation and the wound was closed without drainage. Convalescence was uneventful. The patient was well till 3 weeks before admission, when she had a sudden attack of right-sided lower abdominal pain. This was acute and stabbing in character and persisted for a week before subsiding, but it returned again after an interval of a few days. The pain travelled round into her back. During this time she had considerable frequency of micturition, rising 3-4 times at night.

**Menstrual** F M P 14 years, L M P Feb 17, 1946 Cycle 7/21, regular. No premenstrual or menstrual pain.

**Obstetric** The patient had a five-months' abortion 10 years ago. There was no evidence of sepsis and recovery was rapid. Since then she had had no further pregnancy.

# EXAMINATION—

**General** Revealed nothing of note.

**Vaginal** Extreme tenderness in right lateral fornix with palpable mass. Uterus appears normal.

**OPERATION** (March 11, 1946)—Right salpingo-oophorectomy.

**PATHOLOGY**—The Fallopian tube is grossly swollen and the fimbriae have disappeared, the distal end of the tube being somewhat bulbous. The tube is closely adherent to the ovary, which otherwise appears normal.

Microscopical examination shows gross thickening of the lining with an almost obliterated lumen. The submucosa is replaced by a cellular granulation tissue, infiltrated with inflammatory cells, mainly lymphocytes, plasma cells, and eosinophils, with scanty neutrophils. Epithelial cells occurring in cords are seen in the thickness of this tissue and they are taken to mark the former division into villi, elsewhere they are largely gone. In the deepest portion of the submucosa numerous giant-cell systems are also present and anisotropic foreign bodies are found in relation to these.

The sections are interpreted as showing a combination of a long-standing low-grade pyogenic salpingitis probably to be related to the abortion 10 years before, and a granulomatous reaction to foreign bodies introduced during the appendectomy the year before the abortion.

## SUMMARY OF SIGNIFICANT CLINICAL FEATURES

**1 Lesion occurring in Scar Wound**—Both cases are characterized by the development of a mass in the scar of a previous operation wound with moderate pain or discomfort at this site. The differential diagnosis clinically is from keloid, which, however, generally occurs within a year of operation.

**2 Lesions in the Fallopian Tube**—All 5 cases had undergone a previous laparotomy for appendectomy and apart from the abortion in Case 7 the patients were all subsequently sterile. The symptoms are suggestive of a low-grade pelvic inflammation and physical examination reveals thickened tender Fallopian tubes. In Case 5 the tubal lesion was found during operation for the removal of a large uterine fibroid (see Table I).

Only one patient (Case 4) gives a history of a possible tuberculous infection elsewhere, having had cervical adenitis two years previously. X-ray chest investigation was not undertaken, but no abnormal findings were noted on clinical examination. No history of gonococcal or syphilitic infection was obtained and the sera from all patients gave a negative Wassermann reaction.

Table I—DETAILS OF CASES WITH LESIONS IN FALLOPIAN

CASE NO	AGE, YEARS	YEARS SINCE APPENDICETOMY	MARRIED YEARS	PARITY SINCE APPENDICETOMY	COMPLAINT	CLINICAL FINDINGS
3	28	2	7	—	Pain in left iliac fossa	Tenderness in fornices
4	32	17	9	—	Sterility	Thickened FT's
5	33	10	9	—	Abdominal discomfort	Subserous fibroid
6	26	8	6	—	Post-menstrual pain	Tubo-ovarian masses
7	30	11	10	5/12 abortion	Lower abdominal pain	Tenderness and mass in right fornix

## COMMENTARY

The scar lesion, not hitherto mentioned in the British literature, is of interest in that its close histological similarity to the commoner traumatic lesion and its obvious relationship to the introduction of foreign material at operation provide a linkage with the lesions in the Fallopian tubes. The possibility that a granuloma due to talc might occur in the latter site has apparently not been considered, but the finding of 5 cases of granulomatous salpingitis, in all of which doubly refractive material has been demonstrated, suggests that this is a not so rare late complication of laparotomy.

**Differential Diagnosis**—The histological diagnosis of tuberculosis of the Fallopian tube is an easy matter in the typical case with gross caseation. In the diagnosis of the more proliferative form, the possibility of a silicious aetiology has now to be considered, but in this series the cases in which doubly refractive material has been definitely recognized have shown few, if any, cells that would properly be classified as endothelioid. The possibility that some, if not all, of the present cases have really been examples of silico-tuberculosis is difficult to exclude, since neither culture nor animal inoculation was undertaken in any and the failure to demonstrate tubercle bacilli in the sections cannot be taken as strong evidence, since it is well known how difficult such demonstration frequently is except in the florid type of tuberculosis.

It would seem reasonable in the microscopical examination of the pathological Fallopian tube to accept as primarily silicious a giant-cell granulomatous reaction, with scanty or absent endothelioid cells, absence of caseation, and the presence of doubly refractive material within or closely related to the giant cells. Since the spicules may be very scanty, extremely small, and difficult to see even with the polarizing apparatus, it is advisable in dealing with such a doubtful case to examine sections from several levels in the tube.

**The Refractile Material**—The use of the polarizing microscope is of great value both in

detecting and in identifying foreign bodies present in tissue Stewart (1920) found it of great assistance, particularly in detecting fragments of buried sutures, and investigated the other relatively few causes of double refraction, e.g., collagen fibres, red blood-cells, striated muscle, suture material, and extraneous debris. In the present series the only doubly refractive material accepted as diagnostically significant was that contained within or closely related to foreign-body giant cells.

Morphologically these foreign bodies are most commonly spicules of various lengths, although when within a giant cell they are frequently rounded (Fig 571). This form is seen commonly in the lesions of the Fallopian tube, while spicules are the usual form in the lesions from the abdominal wall (Fig 566). Not all the spicules visible with ordinary light proved to be anisotropic.

Talc, also known as French chalk, soapstone, or steatite, is a naturally occurring magnesium silicate of constitution  $3(\text{MgO})$ ,  $4(\text{SiO}_2)$ ,  $\text{H}_2\text{O}$ , and belonging to crystal system number 4 (Kingzett). The

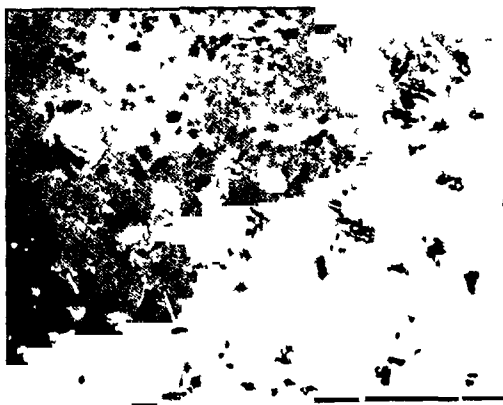


FIG 572—Preparation of surgical talc magnesium silicate. Seen through polaroid screens. This should be compared with Fig 566 ( $\times 150$ ).

standard hospital talc, as used by surgeons for dusting gloves, shows under the microscope a marked similarity in shape and size to the particles present in the tissues. It is noteworthy that not all the particles present in preparations of ordinary surgical talc are doubly refracting (Fig 572).

The more exact identification of the material in the histological sections is a matter of some difficulty. In the traumatic cases described by Faulds the particles were of sufficient size to permit accurate chemical investigation, but in the present cases the particles are very much smaller. However, by the method of Belt and Ferris (1942) the silicious nature of the spicules has been established. Sections from Case 3 were ashed in a micro-incinerator at  $600^\circ\text{C}$  for one hour to remove all organic material, and then treated with concentrated hydrochloric acid to dissolve out the mineral salts, by this means every substance other than silica is removed from the section. The spicules previously seen were still present.

Thus, not only do the spicules have the size and shape of talc, but they are also proved to be silicious.

**Genesis of the Lesion**—The formation of a silicious granuloma in a laparotomy scar seems to differ little from the more common traumatic silicious granuloma. There is the same long latent period and then the production of a characteristic tissue change. The question remains as to the mode of arrival of the silica in the subcutaneous tissues. It seems certain enough that in the post-operative type the silica comes on the surgeon's gloves as talc. Weed and Groves (1942) state that tear or puncture of surgical gloves occurs in about 75 per cent of all operations, and there is, of course, usually a quantity of talc lying in the nail fold, but perhaps even more significant is the statement of Seelig (1943) that talc can be removed from the outer surface of gloves only with the greatest difficulty. Once the talc is deposited in the tissues it appears to be dormant even for years.

This long latent period has also been emphasized by both Shattock and Faulds, dealing with the traumatic type, and indeed recently in this department a small subcutaneous silicious nodule was examined which had developed about 45 years after the original injury. One of the silicious granulomata arising in an appendicectomy scar (Case 1) apparently developed within two months, although the operation had occurred some 11 years before.

The development of the actual lesion in the Fallopian tube is presumably similar to that described in traumatic and post-operative silicious granuloma since it differs from them histologically in minor points only. There seems little doubt that the talc must have been deposited in the peritoneal cavity during operation and the particles may indeed be deposited directly in the pelvis since it is the practice of some surgeons to inspect and palpate routinely the tubes and ovaries.

The possibility is raised, however, by these cases that talc left in the peritoneal cavity at operation may become concentrated in the Fallopian tubes. Once there, the particles penetrate the epithelium and set up a foreign-body granulomatous lesion. The ultimate and important result of this lesion is the architectural disorganization of the delicate structure of the tube, this has been associated in all 5 cases with a serious effect on the fertility of the woman.

#### Relationship to Tuberculous Endometritis

—Within recent years a number of reports have described the finding of tuberculous infections in the endometrium of patients whose only complaint was sterility. Bacteriological investigation of such cases has been made by Sutherland (1943), who, with culture or guinea-pig inoculation, obtained 10 positives out of 16 cases examined. Rabau (1943) examined 4 cases and got 4 positives and Halbrecht (1946 a, b) obtained 7 positives out of 45 cases. There is, therefore, little doubt that a true infection of the endometrium by the tubercle bacillus does in fact occur. Novak (1941) states that in his experience a tuberculous lesion of the tubes is always present in cases showing tuberculosis of the endometrium, and considers that the endometrium becomes infected by material escaping from the Fallopian tubes, and it appeared possible that silicious material could similarly escape and set up a granulomatous reaction in the mucosa. The re-examination of some thirty specimens previously diagnosed as tuberculous

endometritis was undertaken and in none of them was silicious material detected

**Clinical Importance**—The danger of introducing talc into the tissues or body spaces is becoming recognized (*The Lancet*) and suggestions have been made to substitute as glove powder less irritant and less persistent substances (Seelig, 1943) but it is perhaps not yet adequately appreciated that talc in the tissues of the abdominal wall can not only give rise to a painful granuloma, but also, in probably a fairly large number of cases (German, 1944), can act as an irritant in the peritoneum and lead to the formation of adhesions

To these has now been added the possibility that talc particles can settle in the Fallopian tubes and set up there a granulomatous reaction. The finding of 5 such cases within a year at the Western Infirmary, Glasgow, suggests that the lesion is by no means rare. This view is strengthened by the finding of 6 other cases in material filed in other departments as tuberculous salpingitis. It is consequently felt that this condition is of importance not only as a late complication of laparotomy that may demand further operative intervention for the relief of pelvic pain, but also as a cause of sterility.

Treatment of this condition must be prophylactic since surgical cure is unlikely to be possible. When once the silicious particles are deposited it is improbable that surgical treatment could prevent the ultimate occlusion, functional if not organic, of the Fallopian tubes. It is only by recognition of the dangerous potentialities possessed by talc and by a total avoidance of its use that these unfortunate sequelae can be prevented.

### SUMMARY

Seven cases of silicious granuloma are described, 2 occurring in appendicectomy scars and 5 in the Fallopian tubes.

All occurred in cases that had undergone a previous laparotomy, and microscopy revealed the presence in all the lesions of doubly refractive material, this is considered to be talc deposited at the earlier operation. Several of the tubal lesions had been previously diagnosed as tuberculous and

the question is raised whether some cases diagnosed histologically as tuberculosis of the endometrium may not, in fact, be also silicious granuloma.

The presence of this type of lesion in the Fallopian tube can cause pelvic pain and apparently sterility.

I am glad to acknowledge my thanks to Dr A C Lendrum for providing me with the material from Cases 1 and 2, and for his help in the preparation of this paper.

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## AN OPERATION FOR NERVE PEDICLE GRAFTING

### PRELIMINARY COMMUNICATION

By F G St CLAIR STRANGE

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 LATE SENIOR SURGEON AND SURGEON-IN-CHARGE OF THE PERIPHERAL NERVE INJURY UNIT, MINISTRY OF PENSIONS HOSPITAL, DUNSTON HILL

MANY attempts have been made in the past to bridge wide gaps in peripheral nerves by nerve-grafts. Apart from thin grafts, such as cable grafts made from cutaneous nerves, facial nerve-grafts (Duel, 1934), and experimental grafts in rabbits (Young, Holmes, and Sanders, 1940), the usual results have been disappointing. In the light of recent work by Seddon and Holmes (1944) and Barnes, Bacsich, Wyburn, and Kerr (1946), homografts seem to hold no better prospects of success than heterografts.

In the case of full-thickness autografts, Sanders (1942) records that a frequent microscopical finding

is central necrosis of nerve elements, and Sanders and Young (1942) quote many workers as obtaining similar results. Seddon, however, has had some remarkable results from full-thickness free autografts (1946). Fifteen of his 22 cases have been followed up for a sufficient period for results to be assessed, and in 9 of these recovery is as good as the best results from direct suture. At the same time, necrosis has been present in one of his failures.

From this evidence it seems probable that free grafts are capable of survival only if they are thin enough. It seems sensible to assume that there is

a critical thickness over which a free graft will be liable to central necrosis or collagenization and that, below this thickness, the graft survives by virtue of the accessibility to all its Schwann tubes of diffused oxygen, pending the establishment of adequate vascularization

It therefore appears desirable to preserve the blood-supply of a full-thickness graft if possible. This has often been done before, but so far without adequate regard to the essential design of the graft itself (Sanders' summary, 1942)

This paper describes a rational operation for a nerve pedicle graft. The blood-supply is maintained during transfer by making use of the very efficient longitudinal vasa nervorum (Durward, 1944), and the principle is exactly comparable with the familiar full-thickness skin pedicle graft

### CASE REPORT

W W had sustained a severe shell wound of the right forearm on July 30, 1944, with compound fracture of both bones and residual stiffness of the elbow. Further, exploration had shown that there was complete destruc-

tion of both median and ulnar nerves over a distance of 12 cm, from a point 6 cm below the elbow to one 6 cm above the wrist (Fig 573). A pedicle nerve-graft was therefore devised, using the ulnar to repair the gap in the median (Fig 574)

#### Operative Technique—

**FIRST STAGE** (June 28, 1946)—After adequate exposure, the neuromata of the median and ulnar nerves were resected and two proximal faces, containing good bundles, were found. The portion of the ulnar nerve to be used as the graft was then cleared and transected 13.5 cm higher. This was done in such a way as to leave one large longitudinal vessel, visible in the epineurium, intact. In addition, two small lateral vessels near the upper end of the graft were also preserved. During suture of the two distal faces to each other, it was noticed with satisfaction that there was some oozing from that of the graft. The graft was left lying subcutaneously (Fig 575) and the wound closed.

On examination seven weeks later a positive Tinel's sign could be obtained in the graft 5 cm above the suture line.

**SECOND STAGE** (Aug 9)—The ulnar graft and the suture line were exposed, the latter being left incompletely cleared to avoid damaging any new anastomoses.

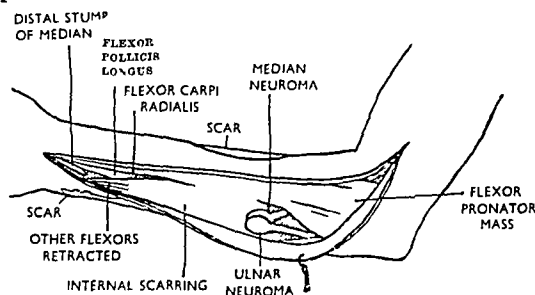


FIG 573—Drawing showing appearances at exploratory operation

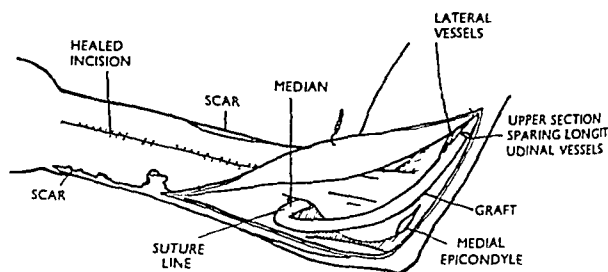


FIG 575—Drawing showing appearances at the close of the first stage of the pedicle graft

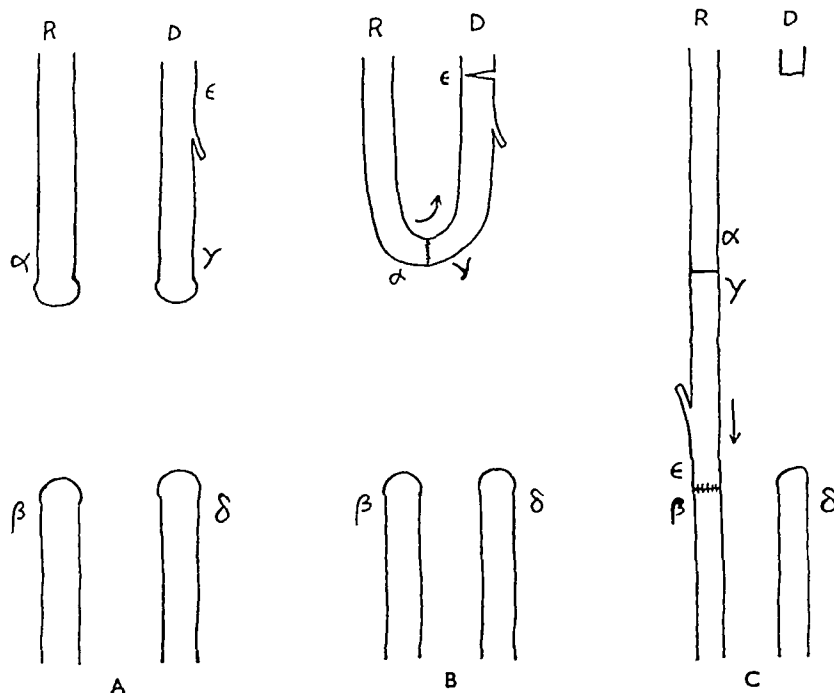


FIG 574—Diagrammatic representation of method of nerve pedicle grafting. R, Receptor trunk; D, Donor. The Greek letters are for identification. The arrows show the direction of regeneration. A, Type of lesion for which the operation is suitable; B, First stage—blood-supply to the graft at  $\epsilon$ ; C, Second stage—blood-supply to the graft at  $\gamma$ .

around it. The graft was more closely defined and appeared healthy, the distal (now physiologically proximal) end was of full thickness and normal consistency, but the end farthest from the suture line was small and felt 'empty'. This end was now divided and swung down through a subcutaneous tunnel and sutured to the distal end of the median after resection of the latter had revealed fair bundles (Fig 576). There was brisk bleeding from the graft face at a time when its sole blood-supply was across the suture line, 12.5 cm away.

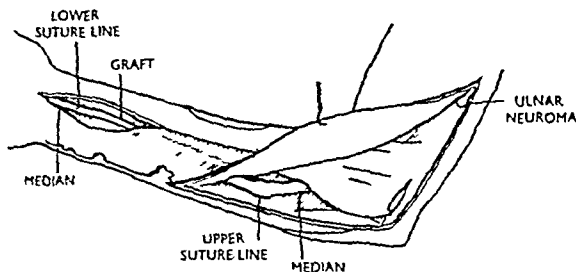


FIG 576—Drawing to give a general impression of the position of the graft at the completion of the second stage

One or two points in the technique may be enlarged upon here. First, section at the higher level is necessary in order that the outgrowing axons of the receptor nerve may have suitable Schwann tubes to enter. Secondly, the distal end of the graft should be resected until good bundles are seen before dividing it at the higher level. In this way, undue dwindling of the graft from the necessity for unexpectedly wide resection need not be feared. Thirdly, the upper point of section of the donor nerve need not necessarily be at the place which will subsequently become its distal face. The higher above this level the better, so that, with the intervening trunk left unstripped, there will be the best available blood-supply for the graft during the first stage. Indeed, the graft itself need not be stripped beyond the amount required to allow comfortable apposition at the first suture line.

## DISCUSSION

The timing of the second stage of this operation may perhaps be discussed briefly. The earliest time at which it is feasible is clearly limited by the time required for a good anastomosis to develop across the suture line, and three weeks is suggested as a minimum. Thereafter any convenient time may be chosen for the completion of the second stage.

Schwann tubes will bridge the lower junction even if the axons have not reached the end of the graft (Young et al., 1940; Sanders and Young, 1942). In the case described by Seddon, Young, and Holmes (1942) it was found that the fibres that had grown down the graft were separated from the peripheral stump by scar tissue and had sprouted out in all directions in the lower junction scar. This was, however, considered to be due to proliferation of fibrous tissue from the distal stump which was somewhat fibrotic at the time of operation, and not to the absence of axons at the time that the suture was performed. The latitude allowed by pedicle grafting should make it possible to eliminate this danger by resection of the distal stump low enough to obtain an ideal face.

The applicability of the operation is recognized as being highly circumscribed. For example, the traction lesion of the brachial plexus and of the lateral popliteal nerve at the knee can hardly be

expected to benefit from it. Further, it is essentially dependent, in my view, on there being a double lesion. I would hesitate to emulate Flourens (quoted by Sanders, 1942) and advocate the sacrifice of an intact main trunk, even for the median, though I do not think there need be any qualms about using a damaged ulnar or radial for the median, or lateral popliteal division of the sciatic for the medial.

In spite of its limitations I feel that the operation is worth recording now on the grounds that others working in this field might find isolated opportunities for employing it, particularly in Service patients whose injuries might well be too old for any hope of improvement if this report were held up until a final result of the particular case could be given. It is the principle, not the case, that is the reason for this contribution. Obviously it is a principle that is capable of considerable expansion in its application and variation in detail, though it is not possible to suggest them all here.

If this paper simply serves to canalize thought and research into what may prove to be a progressive direction, it will, perhaps, have been of some value.

## SUMMARY

A rational pedicled nerve autograft is described, and should surmount many of the problems hitherto associated with nerve-grafting.

In particular, it eliminates a period of ischaemia, whether relative or absolute, so that there need be no cause for anxiety for the fate of the axons during their passage through the graft. As good an upper suture line can be obtained as in direct nerve suture, and there will be properly apposed outgrowing axons and Schwann tubes. There is no loss of regenerating axons into a host nerve-trunk, as in the only previously described 'true nerve pedicle graft'.

It is hoped to submit a follow-up report of the case when the result is known. At present (Nov 18, 1946) Tinell's sign has steadily advanced as far as the necks of the metacarpals.

My thanks are due to Sir Walter Haward, Director-General of Medical Services of the Ministry of Pensions, for permission to publish this paper, and to Professor H J Seddon for his generous advice in its presentation and permission to quote from a paper at present in the press.

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## SHORT NOTES OF RARE OR OBSCURE CASES

### A CASE OF MYXOMATOUS TUMOUR ARISING IN THE ADVENTITIA OF THE LEFT EXTERNAL ILIAC ARTERY

By H J B ATKINS

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AND J A KEY

ASSISTANT DEMONSTRATOR OF ANATOMY

THE following case is reported because, so far as can be ascertained, no other similar case is to be found in the literature

#### CASE REPORT

**HISTORY**—The patient, a man aged 40, was admitted to Guy's Hospital on Jan 27, 1946. For the previous four months he had complained of pain in the muscles of the left leg on exertion. Apart from an attack of

mile, but the condition had progressed in severity, so that at the time of his admission it appeared after walking 100 yards, and after a further 200 yards so incapacitated him that he had to rest. The pain then passed off.

The distribution of the pain had remained constant. The left quadriceps group was first affected, with subsequent spread to the calf muscles and then to the tibialis anterior. It was made worse by cold and wet weather and by the intensity of muscular exertion. Thus he could avoid the pain indefinitely if he strolled gently instead of walking at his usual pace.

Two and a half months before admission, he was diagnosed elsewhere as thrombo-angitis obliterans and treated by diathermy, with slight improvement. There was no history of trauma.

**CONDITION ON ADMISSION**—The patient looked well and was of muscular build.

#### Cardiovascular System—

B.P. 120/80, equal in both arms and legs.

Heart—no enlargement or abnormality.

Brachial vessels palpable and normal.

Posterior tibial pulse—readily palpable on both sides.

Dorsalis pedis pulse—readily palpable on both sides.

Both retinæ were normal.

**Other Systems** No abnormality could be detected.

#### Routine Investigations—

Urine—normal.

Blood W.R. and Kahn both negative.

X-ray examination of heart and chest showed no abnormality, and of pelvis and lower limbs showed no vessel calcification.

#### Special Investigations on Left Leg—

##### 1. On Exercise—

*a* Pain could be induced by 35 full movements of dorsiflexion and plantar-flexion against the resistance of a hand applied to the sole of the foot. The distribution of the pain was as previously described.

*b* Stepping up and down off a stool 2 ft. high, at the rate of one step every two seconds, produced pain in fifty seconds.

*c* When walking on the flat in the warm ward, the sensation of pain was first noted after 98 steps, and after 280 steps the patient had to halt on account of the severity of the pain. The posterior tibial pulse became barely palpable, and the popliteal pulse was diminished while the pain persisted. The limb became increasingly cold and white. Over the base of the femoral triangle, there developed a palpable thrill and an audible systolic murmur.

*d* All these phenomena disappeared on cessation of the exercise.

##### 2. Sympathetic Innervation—

*a* Spinal anaesthesia, after an initial fall in skin temperature, produced a steady rise over 60 minutes from 28.4° C. to 33.0° C. in both limbs. This was accompanied by flushing.

*b* Left paravertebral sympathetic block anaesthesia produced a rise in skin temperature of 2.0° C. in the left limb, accompanied by flushing.

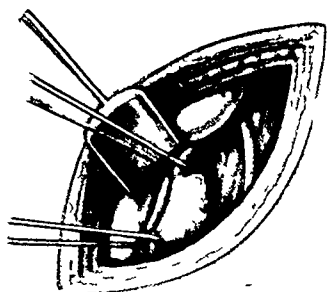


FIG 577—Showing the growth on the left external iliac artery

measles as a child, he had suffered from no other previous illness. One of his brothers had died of pulmonary tuberculosis many years ago.

He was of athletic build, and had served in the Army from 1921 to 1929, when he joined the police force, where for ten years he did foot patrols. He smoked twenty cigarettes a day and was of temperate habits.

**History of Present Illness**—For four months the patient had complained of pain in the left leg on exertion. At first the pain came on after he had walked about half a

After this last procedure, the exercise test in 1 (b) was repeated, and no pain developed after three minutes.

**PROVISIONAL DIAGNOSIS**—On the clinical findings, a diagnosis of thrombo-angitis obliterans (Buerger's disease) was made, and lumbar sympathectomy was advised.

**SUBSEQUENT HISTORY**—Admission to the surgical wards was delayed at the patient's own request as he had some business to attend to, and he was eventually re-admitted to hospital six weeks later for operation.

Examination on re-admission revealed that the symptoms were unchanged, but on palpation in the left iliac fossa there was now a painless lump about the size of a golf ball. It was situated above the inguinal ligament in the line of the external iliac artery, it was smooth in outline, non-pulsatile, and slightly mobile from side to side. It was apparently deep to the external iliac artery, and as the radiograph of the pelvic bones was normal and there are no lymph-glands in this situation, it was thought to be a tumour of the psoas or iliacus muscle. In view of these fresh findings, exploration of the external iliac artery was advised.

**OPERATION**—The left external iliac artery was exposed through Abernethy's incision, and a small growth, greyish-red in colour, was found arising from the posterior aspect and investing the middle third of the artery (Fig 577). It had a slightly lobulated appearance and was cystic. There was a considerable degree of periarterial fibrosis, which rendered it relatively fixed. The growth was non-pulsatile.

Dissecting the mass off the artery was difficult, and at one point the wall of the artery was ruptured. This was repaired with fine paraffined silk, and the portion of the cyst, which was so intimately incorporated in the

artery at this point, had to be left in situ, while the rest was dissected free from the surrounding tissues and removed. The remaining wall was smeared with pure carbolic.

The external iliac artery above and below the lesion was then examined and appeared healthy, as did the accompanying vein. The wound was closed in layers and the skin approximated with clips.

On examining the excised growth it was found to be a typical ganglion containing myxomatous tissue.

**POST-OPERATIVE COURSE**—The patient's convalescence was uneventful, and he was discharged in a fortnight. He has remained completely free from symptoms.

**Discussion**—It is held that 'ganglia' may occur wherever there is mesodermal tissue, but the appearance of myxomatous degeneration in an artery wall is exceptionally rare, and such a change giving rise to symptoms of intermittent claudication by pressure on the external iliac artery is, so far as we know, unreported. An interesting feature of the case was the palpable and audible thrill which occurred over the diseased portion of the artery after exercise, and the significance of this physical sign was freely discussed when the patient was first admitted to hospital and at a time when, in the absence of a palpable tumour, a diagnosis of thrombo-angitis obliterans had been entertained. It was then remarked that a thrill had never been noted in this disease before, and a careful investigation was conducted in order to eliminate the possibility of iliac aneurysm.

## A CASE OF MESOTHELIOMA OF THE EPIDIDYMIS

By T C PATTERSON, SURGEON CAPTAIN, R N (RET)

AND R A MOGG, SURGEON LIEUT-COMMANDER, R N V R

SPECIALIST IN UROLOGY

TUMOURS of the epididymis have always been considered by medical writers to be most uncommon and very little has been recorded concerning them. Most text-books on pathology dismiss them shortly with the remark that they are very rare. From time to time, however, isolated groups of cases have been described under a variety of pathological classifications and it was not until the work of Newton Evans (1943, a) was presented, that the pathology of these tumours became clarified. Formerly the terms used in the descriptions represented a pathological miscellany, and such names as lymphangioma, adenocarcinoma, and benign adenoma were used. The following case is presented on account of its interest, and a brief review of the literature as analysed by Evans is appended.

### CASE REPORT

C R, Lt, Royal Marines, was first seen by one of us (R A M) on account of a hard painless swelling of the right epididymis which had been present for one year. The patient only presented himself for examination to ascertain his fitness for foreign service. There was a history of trauma to the right testicle by a hockey ball, approximately six years previously. The swelling which resulted from this trauma, and which was considered to be a hæmatoma of the testicle, subsided completely within a few months of the injury. The

present swelling was first noticed accidentally by the patient about one year before examination, and it had gradually increased in size painlessly since that time. There had never been any evidence of a hydrocele, neither had there been any urinary symptoms.

**ON EXAMINATION**—There was a small, hard, spherical nodule about an inch in diameter situated in the globus major of the epididymis, without any evidence of involvement of the scrotal skin. There was no hydrocele and no lymphadenopathy. Rectal examination was negative.

**AT OPERATION**—Under pentothal, nitrous oxide, and oxygen anaesthesia, the epididymis was exposed through a midline scrotal incision, the tunica vaginalis was normal and did not contain any excess fluid. The tumour was of the size described above, encapsulated in the globus major of the epididymis, while the rest of the epididymis and testicle were macroscopically normal. Right epididymectomy was performed and the wound closed with drainage. Convalescence was normal. Patient was discharged from hospital nine days after operation and has remained entirely fit.

**THE SPECIMEN**—This was examined by one of us (T C P) and it was found that there was a hard spherical encapsulated tumour about 2.5 cm in each diameter, occupying the globus major. The cut surface of the tumour had a faint branching pattern and was smooth, moist, firm, homogeneous, and cream coloured (Figs 578, 579).

Microscopically it showed as a very cellular tumour with only sparse connective-tissue elements, which consisted of strands of fibrous tissue and unstriated



muscle. The cellular parts were loose, there being many empty spaces, apparently lymphatic, and also many globules and vacuoles. The essential stroma consisted of a delicate rarefied network of collagen, suffused with lymphocytes, together with a few eosinophils and plasma cells, in places the lymphocytes were

pericardium constitute a mesothelium, Newton Evans (1943, b) has shown that tumours of identical microscopical structure to mesotheliomata have been

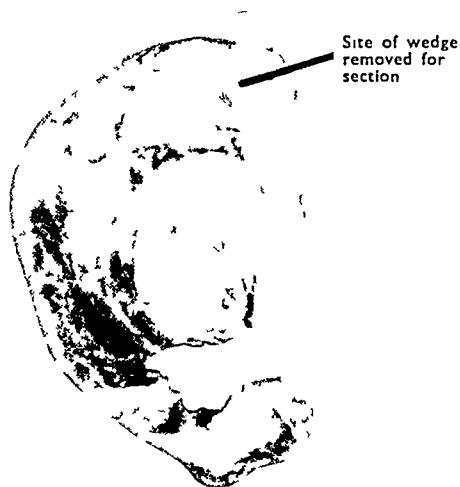


FIG 578—Tumour of head of epididymis as resected ( $\times \frac{1}{2}$ )

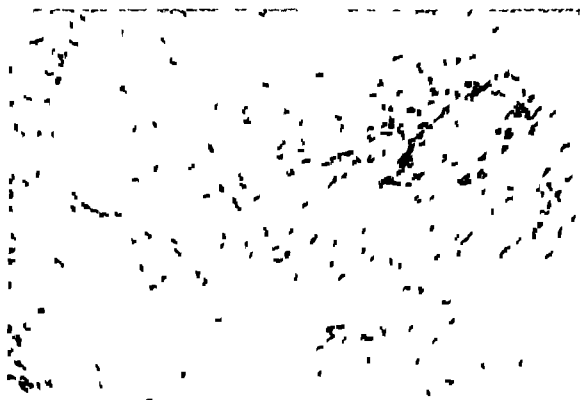


FIG 580—Loose interlacing pattern of fine supporting tissue beset with cells and spaces H and E ( $\times 60$ )

arranged in denser clumps. The constituent tumour cells were large and polygonal in shape, with abundant non-granular cytoplasm and often containing vacuoles. The nuclei were oval, moderately vesicular, with a distinct nucleolus. These cells occurred in branching sheets or narrow columns with clefts between them, but in places pseudo-acini were seen, which gave the impression of being formed from coalesced vacuoles. Fine capillary vessels were common throughout the section. (This description conformed with the recognized characteristics of a mesothelioma.)

## DISCUSSION

The term 'mesothelioma' is given to a tumour which arises from the lining cells of the serous membranes of the various body cavities, and histologists are in agreement that the covering cells of the pleura, peritoneum, tunica vaginalis, and the



FIG 579—Tumour bisected, showing solid homogeneous interior (Retained as hospital museum specimen) ( $\times \frac{1}{2}$ )



FIG 581—Constituent cells—large, clear, polyhedral frequently vacuolated. Lymphocytes common in the stroma H and E ( $\times 225$ )

found to occur on the serous surfaces of the uterus and the Fallopian tubes, and that the cells in the gland-like spaces of the tumour have a direct connexion with the cells covering the serous surfaces of these organs. Therefore it may be assumed that the tumours arising in relation to the tunica vaginalis, having as they do a structure identical with those arising from the female pelvic peritoneum in relation to the uterus and the Fallopian tubes, must have a common origin from the mesothelial cells of the serous membrane. It is possible, then, that these tumours arise from the mesothelium covering the urogenital ridge of the embryo.

It is held by some authorities that somewhat similar growths may be definite adenomata arising from rete testis or more particularly from a remnant of paradidymis.

Mesotheliomata are a group of slow-growing tumours, usually small in size, solitary, and with a well-defined capsule. They are benign in character and can be removed quite easily surgically. They occur most frequently in relation to the lower pole of the epididymis. In the majority of cases there is a history of trauma to the affected part, but it is very doubtful if this is an aetiological factor in the production of these tumours.

Microscopically they present a characteristic appearance and at first sight appear to be adenomata, from the way in which the groups of cells are arranged. The tumour cells in mesothelioma vary in size, shape, and arrangement, ranging from flat plates to a low columnar type. The characteristic feature of the cells is that large numbers of them have a vacuolated cytoplasm and, while many of them are arranged in solid groups, others have a definite adenomatous formation. Another characteristic feature is the presence of numerous lymphoid-like cells scattered throughout the tumour. The microscopical structure of the specimen referred to in this article closely resembles the above description, as can be seen by examination of the photomicrographs (Figs 580, 581).

It is quite evident on careful study of the cases previously reported as adenomata, adenocarcinomata, and lymphangiomas of the epididymis, that the tumours really belonged to the class of mesotheliomata. For instance, in two of the three cases quoted by Thompson (1936), and diagnosed as adenocarcinomata, the patients were alive and well

eighteen and twenty years after simple local excision of the respective tumours. Similar results are quoted by Charache (1939) and Newton Evans (1943, a). Gordon-Taylor and Ommamey-Davis (1941) record a case which was designated as "an adenoma, probably from some aberrant cells in connexion with the mesonephric duct", occurring in relation to the lower pole of the epididymis, which was treated by orchidectomy with complete recovery. The adenoma of Blumer and Edwards (1941) was of much the same nature as the foregoing. It occurred in a man aged 54, and was made up of tubular formations lined by cubical to flattened epithelium simulating epididymal structure, lymphocytes were scattered in the stroma. The growth had been present since boyhood, was easily dissected away from the otherwise healthy testis and epididymis, and recovery was uneventful.

We tender thanks to Surgeon Vice-Admiral H St C Colson, CBE, Medical Director-General, Royal Navy, for approval to submit this contribution for publication.

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## PENETRATING CHEST WOUND WITH LODGEMENT OF THE FOREIGN BODY IN THE COMMON BILE-DUCT

By R LAMBERT HURT

SURGICAL REGISTRAR TO AN E M S CHEST UNIT

THIS case is thought worthy of record not only because it may be unique, but also because of the interesting problem of diagnosis involved.

### CASE REPORT

A B, aged 19 years, was wounded by a mortar bomb explosion in Normandy on June 28, 1944. The entry wound was in the right lower chest in the posterior axillary line, and there was no exit wound. A laparotomy performed the day after wounding on account of upper abdominal pain and tenderness revealed a small hole in the right diaphragm and a laceration in the superior surface of the liver. There was no other visceral damage, and the wound was closed without drainage. Apart from a temporary collapse of the right lower lobe, he progressed quite satisfactorily until July 14 (16 days after wounding), when he developed acute epigastric pain and vomited on several occasions. The next day he developed signs of consolidation at the right base and began to cough up bile-stained sputum, which on bronchoscopy was seen to be coming from the right main bronchus.

When admitted to this Chest Unit a week later, he was a very ill man, coughing up over  $\frac{1}{2}$  pint of heavily bile-stained sputum daily, and with signs of consolidation over most of the right lung. An X-ray picture of his chest showed an area of increased opacity in the right lower lung field, a fluid level in the lower axillary region,

and a metallic foreign body apparently deep in the substance of the liver. In order to prevent his continued expectoration of bile with its irritating effect on the lung, a portion of the 8th rib was resected in the posterior axillary line, and a small pleural space opened. A bronchial fistula into the lower lobe was seen and, in addition, there was a sinus leading through the diaphragm into the right lobe of the liver. It was not possible to feel the foreign body in the liver substance, so two tubes were inserted, one into the liver, and one into the empyema cavity (Fig 582).

The sputum continued to be a little bile-stained for two weeks, but there was an immediate reduction in the amount of bile present, and within a month the lung had cleared completely. There was still a bronchial fistula present, however, and it was decided that an attempt should now be made to close it, subsequently the liver could be explored in order to remove the foreign body. This closure was effected by suturing a flap of latissimus dorsi over the fistula. The sinus leading into the liver was dilated with bougies, and although it was then possible to feel the foreign body, the track was too long and narrow to remove it with safety by this route. A small-bore rubber drainage tube was inserted into the sinus, and a gauze pack placed in position between the muscle-graft and the tube. The graft took successfully and the fistula was obliterated, thus leaving the patient with a sinus in the lower chest, from which bile discharged in varying amounts.

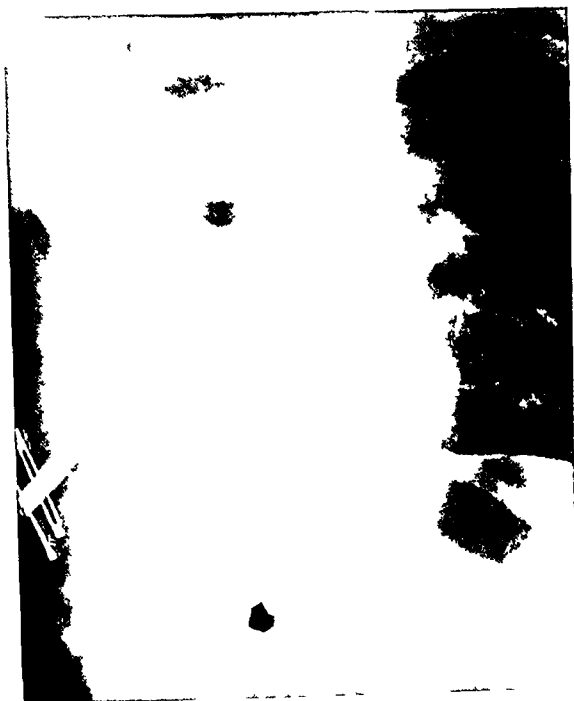


FIG 582—Radiograph one week after rib resection, showing biliary pneumonia, bomb fragment, and drainage tube in empyema cavity (the tube leading into the liver was not a barium tube, and so cannot be seen)



FIG 583—Radiograph after introduction of lipiodol into liver sinus, showing a short wide channel (the common bile duct) stopping abruptly at the bomb fragment. The narrow shadow overlying the last rib is due to lipiodol in a hepatic duct

On several occasions the patient complained of right upper abdominal pain, and at the same time the stools became clay-coloured. He did not become jaundiced during these attacks, nor was any gall-bladder or liver enlargement detectable, but it was noticed that there was an increased amount of biliary discharge from his chest sinus. This picture of abdominal pain and pale stools bore a striking resemblance to that seen in obstruction of the common duct by a calculus. An X-ray picture after lipiodol had been introduced into the chest sinus showed a short wide channel filled with oil which stopped abruptly at the foreign body (Fig 583). This shadow was in a position compatible with its being the common bile-duct, and these appearances, combined with the clinical picture, made us feel that the foreign body must be actually in the common bile-duct, and so causing its intermittent obstruction.

A laparotomy was performed on Jan 11, 1945, just over six months from his initial injury, and a piece of metal  $\frac{1}{2} \times \frac{1}{4} \times \frac{1}{4}$  in was palpated in the common bile-duct just below the point of entry of the cystic duct. The duct was incised and the piece of metal was removed. After sucking out a fair quantity of biliary mud, a catheter was passed up and down the common duct to confirm its patency. The common duct was sutured around a T-tube and the abdomen closed with a corrugated rubber drain going down to the neck of the gall-bladder. The patient subsequently made an uninterrupted recovery. The T-tube was removed after two weeks, his stools became a normal colour, and both his chest and abdominal wounds rapidly healed. When seen a year later he remained perfectly well except for a slight unproductive cough.

**Comment**—The main interest of this case lies in the final position of the foreign body, which came to rest in the common bile-duct, having penetrated the chest and traversed the diaphragm and liver.

In this situation it periodically caused an obstruction to the flow of bile into the duodenum which was unaccompanied by jaundice because the sinus through the diaphragm to the empyema drainage site provided a safety-valve mechanism through which the bile was able to discharge. An increase in the flow of bile from the chest sinus was very noticeable whenever the patient developed upper abdominal pain, and each time following this the stools became clay-coloured. The absence of any enlargement of the gall-bladder or liver was confirmed at operation.

The extremely irritating effect of bile on the lung substance was well shown by his condition on admission, and this biliary pneumonia rapidly resolved following the insertion of a drainage tube into the pleural cavity, with the resulting almost complete cessation of biliary expectoration. Although bronchography has not been performed, clinical examination and radiography revealed no permanent pulmonary damage.

It is considered probable that the foreign body initially lay in one of the hepatic ducts, and subsequently descended to its final position. Had the piece of metal penetrated the common duct, there would almost certainly have been evidence of this at operation, but in actual fact there were no adhesions around the common duct, nor any evidence of its having been injured.

I should like to express by thanks to Mr O S Tubbs for permission to write this account, and for his very valuable assistance in its preparation, also to Dr B G Wells for the photographs.

# TRAUMATIC PARARENAL PSEUDOHYDRONEPHROSIS

## REPORT OF A CASE

By B E CRAWFORD STANLEY

TRAUMATIC pararenal pseudohydronephrosis, or, as it has been variously called, hydrocele of the kidney, hydropertinephrosis, renal hygroma, or perirenal hydronephrosis, is an uncommon condition to which few references have been made in British medical literature

Crabtree (1935) presented a full account of the condition and described a number of cases of his own and other surgeons. In the majority of the cases described the patient was either not cured or suffered the loss of the affected kidney. Woodruff and Rupert (1939) mention the possibility of preserving the kidney as being unlikely, but say that it might be done in the case of a small cyst. In the case described below a large cyst was satisfactorily removed. The affected kidney was not excised, but it was subsequently found to have some impairment of function

## CASE REPORT

**HISTORY**—J P, a man 23 years of age, gave the following history. Six weeks previously he had been involved in a car accident and sustained a lacerated forehead, a small fissured fracture of the left frontal bone, fractured right transverse processes of the 3rd and 4th lumbar vertebrae, and a closed lesion of the right kidney. After this injury he had hæmaturia for about a week. He had made good progress but was not yet discharged from hospital.

He complained of increasing pain in the right loin of about a week's duration. The pain was continuous, but not severe, and it did not radiate.

**ON EXAMINATION**—His general condition was good. His temperature rose each evening to about 100.5°, but he had very little constitutional upset. There was a large tumour in the right loin. This tumour extended forward to the umbilicus and downward to the anterior superior spine. It was slightly tender.

### Investigations —

**Urine** A few pus and epithelial cells. Sterile on culture.

**Blood-urea** 27 mg per 100 c c

**White blood-cells** 7800 per c mm. Differential count normal.

**Barium enema** Ascending colon displaced anteriorly and toward the midline.

**Intravenous pyelogram** Left kidney functions normally, no excretion from right kidney.

**Cystoscopy** The bladder appeared normal, but no efflux was seen from the right ureter. A ureteric catheter passed up the right ureter was obstructed at the level of the 4th transverse process. An attempt to inject sodium iodide resulted in regurgitation of the fluid into the bladder along the side of the catheter. When the force of the injection was increased a very little sodium iodide solution passed into the kidney, but not enough to show the outline of the pelvis (Fig 584).

**OPERATION**—Under general anaesthesia an oblique incision was made in the loin. The tumour was found to be a large cyst containing urine and was situated on the anterior and lateral aspects of the right kidney. The cyst wall was about ½ in thick and consisted of dense fibrous tissue with a smooth lining. After the cyst had been opened widely, the kidney was seen lying in its

medial wall, and it was possible to dissect the cyst wall piecemeal. An apparently healthy kidney remained, stripped of its capsule on its anterior and lateral aspects. Urine was seen to be leaking through a small hole in the lower pole of the kidney. A drainage tube was inserted and the incision in the loin closed in layers.



FIG 584—Attempt at ascending pyelogram before operation

**PROGRESS**—After operation the wound discharged urine freely, necessitating very frequent dressings.

On the fifth day after operation cystoscopy was performed, and a ureteric catheter was passed easily up into the right renal pelvis. On injection of sodium iodide the pelvis was shown to be dilated and there was a leak through the inferior calix into the perirenal tissues (Fig 585). The ureteric catheter was left in position for twelve hours and during this time several ounces of urine drained through it. After the removal of the catheter the wound in the loin dried up very quickly. The tube was removed on the eighth day after operation and the wound was soundly healed by the fourteenth day.

Four weeks after operation the patient was very well and had no symptoms. An intravenous pyelogram showed slightly delayed excretion from the right kidney, which had a mild degree of hydronephrosis (Fig 586).

## DISCUSSION

The pathogenesis of the condition is a rupture of the kidney which involves the renal pelvis. A hæmatoma in the perirenal fat develops, and into it there is a leak of urine. The rupture in the kidney substance fails to heal and the escape of urine continues into the cavity of the organizing hæmatoma.

which is bounded by the perirenal fat and the fascia of Gerota. The absence of perirenal fat which is found at operation on these cases is reported as a regular occurrence and indicates that the cyst is formed in this layer (Johnson and Smith, 1941). An

delayed healing of the kidney, and ureteric obstruction.

3 Removal of the cyst was possible with preservation of the kidney, which showed some impairment of function.



FIG 585—Ascending pyelogram five days after operation, showing leak through the lower calyx. Drainage tube in position.



FIG 586—Intravenous pyelogram four weeks after operation.

essential factor in the formation of the cyst is the existence of ureteric obstruction. This may be due to pressure of extravasated blood that occurs at the time of the original injury or to an intra-ureteric clot. This has been proved by the experimental production of similar cysts in animals (Razzaboni, 1922).

### SUMMARY

1 A case of pararenal pseudohydronephrosis is described.

2 Factors concerned in the formation of such cysts are trauma involving the calyx of a kidney,

I wish to express my thanks to Capt J C Fulford, R A M C, for his help in the management of this case.

### REFERENCES

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## EXOSTOSIS OF THE CORONOID PROCESS OF THE MANDIBLE AND TRUE JOINT FORMATION WITH ZYGOMATIC ARCH

By JOHN W HALLAM

DENTAL SURGEON E M S PLASTIC AND JAW INJURY UNIT, LIVERPOOL

### CASE REPORT

The patient, a male aged 18, was referred to me complaining of swelling of the left cheek which had been present for about two years. He had a history of having been struck on the cheek some months previously by a cricket ball, but this was after the swelling had started.

ON EXAMINATION—A bony hard swelling of the cheek was apparent, portions of the swelling appeared to move

when the mandible was moved. There was a slight limitation of movement of the mandible in all directions, nothing could be felt from inside the mouth (Fig 587).

Radiographs were taken and revealed an exostosis of the coronoid process of the mandible with expansion of the zygomatic arch. In view of the gradual increase in size it was decided to excise the exostosed coronoid process.

AT OPERATION (Mr Robert Kennon)—The zygomatic arch was divided in two places 1 in apart over the swelling,



FIG 587—Photograph showing the swelling of the cheek.

and on raising it up the appearance of a true joint was revealed. The coronoid was divided below the exostosis with bone shears and was shelled out readily. The zygomatic arch was replaced and the wound was closed.



FIG 588—The exostosis

The patient made an uneventful recovery and was discharged from hospital one week later.

Fig 588 depicts the exostosis, on section it was indistinguishable from bone, with a healthy and normal joint surface. A post-operative radiograph revealed a still slightly enlarged coronoid.

## REVIEWS AND NOTICES OF BOOKS

**Ambulatory Proctology** By ALFRED J. CANTOR, M.D., Associate Proctologist, Kew Gardens General Hospital, Long Island, New York. With a Foreword by BEAUMONT S. CORNELL, M.D., Editor, *American Journal of Digestive Diseases*. 9 × 6½ in. Pp 524 + xviii, with 281 illustrations. 1946. London: Hamish Hamilton Ltd. 42s net.

THIS new work provides a good deal of interest, particularly from the aspect of diagnosis. Many of the operations recommended as ambulatory procedures, such as hæmorrhoidectomy, fistulectomy, excision of the coccyx and pilonidal sinuses, and various operations for prolapse, as well as plastic procedures for anal incontinence, are in this country considered to be better treated by formal operations with in-patient care. Those with experience of rectal work will, however, gain some fresh ideas by reading this book even if they do not approve of much that is recommended. The injection methods are well described, and, of course, anal papillæ and cryptitis receive their due measure of attention.

The middle section of the book, Chapters XIII to XXIII, on colitis, dysentery, tuberculosis, parasites, and venereal diseases affecting the rectum and anus, are sound and up to date.

The illustrations are large, clear, and well chosen. A useful bibliography is given to each chapter.

**Renal Diseases** By E. T. BELL, M.D., Professor of Pathology in the University of Minnesota, Minneapolis, Minnesota. 9½ × 5½ in. Pp 434, with 115 illustrations and 4 coloured plates. 1946. London: Henry Kimpton. 35s net.

THIS monograph is the result of twenty-five years' study of the pathology of renal diseases, and the author is to be congratulated on the vast amount of new work which is incorporated in the volume. Of necessity, the accumulated knowledge of a quarter of a century in any keen and active investigator must be fruitful, for such a man can impart knowledge in a mellowed and constructive form. This is what we find in this book. The author discusses the structural changes in the kidneys, the pathological physiology, and the clinical manifestations of different

diseases. The relation of hypertension to the kidneys is discussed fully, and there is a discussion of the toxæmias of pregnancy and the renal lesions in diabetes. New growths of the kidney receive adequate notice.

The surgeon of to-day must know more and more about medicine and pathology and this book should prove of real value to the practical surgeon. The closer the co-operation between clinician and pathologist, the better for the future of medicine in all its branches.

**L'Osteosynthese au Clou** By R. SÆUR, Chirurgien-Adjoint des Hôpitaux de Bruxelles. 9½ × 6½ in. Pp 132, with 134 illustrations. 1946. Paris: Masson et Cie. 325 fr.

THIS book is an account of methods of treating fractures by the introduction of nails.

The methods described include the introduction of a bar of steel into the medullary cavity of long bones, and the removal of the bar after consolidation of the fracture.

Another method is the classical one of the Smith-Petersen pin for fractures about the neck of the femur. Then there is a new and original method, according to the author hitherto unpublished, which describes the treatment by a nail with a double hook. This is designed to surmount some of the shortcomings found in methods previously described.

**Thromboses artérielles** Physiologie pathologique et Traitement chirurgical. By RENE LÉRICHE, Professeur au Collège de France, with the collaboration of D'IVAN BERTRAND, Directeur de l'Institut de Neurobiologie à la Salpêtrière. 9 × 5½ in. Pp 537 + viii, with 59 illustrations. 1946. Paris: Masson et Cie. Fr 600.

THIS book may be regarded as the author's collected work on the pathological physiology of vascular disease and the syndromes of causalgia, muscular contracture, œdema, ischæmic necrosis, and pain which are associated with vasomotor disorders. Though arterial thrombosis, its causation, evolution, and effects, acts as a framework for the complete structure of the book, Leriche has built

so much on to it that the title of the work is such an understatement of its scope as to be almost misleading.

The early pages deal with the pathology of arterial thrombosis in general, and certain laws are enunciated which regulate the behaviour of clots, and the ischaemic phenomena produced by them. The rest of the book is divided into three parts. First, traumatic thrombosis due to contusion and rupture of arteries is considered, with the treatment of Volkmann's contracture and ischaemic necrosis. The second part deals with spontaneous thrombosis occurring in obliterative arteritis, and it is of special interest that pathological changes in the sympathetic ganglia are described which may be of aetiological significance in certain forms of structural disease of the arteries. Treatment by conservative measures, adrenalectomy, sympathetic ganglionectomy, and amputation are considered in full, and a special plea is made for further research directed to establish the proper role of adrenalectomy, since Leriche suggests that the secret of arteritis may lie in the endocrine system. In the third part he describes thrombosis in vessels other than those of the limbs—the abdominal aorta, and the coronary arteries—which affords an opportunity for a discourse on the treatment of angina pectoris.

It is not easy to review so large a work in a few sentences, but enough may have been said to indicate that this is really the confession of faith of a great surgeon who will long be remembered for the originality and enthusiasm which have enabled him to contribute so much to the elucidation and treatment of vascular disease.

**A Synopsis of Surgical Anatomy** By ALEXANDER LEE MCGREGOR, M Ch (Edin), FRCS (Eng), Surgeon, Johannesburg General Hospital, Lecturer on Surgical Anatomy, University of Witwatersrand. With a Foreword by Sir HAROLD J STILES, K BE, FRCS (Edin). Sixth edition  $7\frac{1}{2} \times 4\frac{1}{2}$  in Pp 714 + xvi, with 699 illustrations. Bristol: John Wright & Sons Ltd. 25s net.

THIS book is already firmly established as one which deals with anatomy from a surgical as well as an academic aspect. It probably contains more anatomical detail useful to the surgeon than any other of its kind. The sixth edition contains a revised account of Volkmann's contracture, whilst pressure is admitted as a possible cause more stress is placed on vasoconstriction due to sympathetic injury. The functions of the nerves supplying the urinary bladder are also discussed on more modern lines, the theory of sympathetic and parasympathetic antagonism being rejected for this viscus and recognition being accorded to the paramount importance of the parasympathetic for storage and evacuation of urine.

The student with a good knowledge of topographical anatomy will find here the way in which to develop and apply it.

**Minor Surgery** (Heath Pollard Davis Williams) For the Use of House Surgeons, Dressers, and Junior Practitioners. By CECIL FLEMMING, O BE, M Ch, FRCS, Surgeon, University College Hospital. With a chapter on The Administration of Anaesthetics by H N WEBBER, B Ch, D A, Anaesthetist, University College Hospital. Twenty-third edition  $7\frac{1}{2} \times 4\frac{1}{2}$  in Pp 406 + viii, with 209 illustrations. 1946. London: J & A Churchill Ltd. 14s net.

THERE is no need to praise a book which has survived for eighty-six years and reached twenty-three editions. The foundations laid by Christopher Heath have proved lasting, and the superstructure added by subsequent surgeons of University College Hospital has maintained the tradition of good craftsmanship. There are one or two minor points in which improvements could be effected, the diagrams on p 32 of a ligature being tied

with forceps would be more easily followed if one end of the ligature was held in dissecting forceps, as is usually the case in practice. The kidney position on p 23 is shown with the lower leg extended and the upper flexed, the opposite of that described by Thomson-Walker, and a position which allows of rotation. The method of suprapubic drainage of the distended bladder "immediately above the symphysis pubis" is one which leads to difficulties in the later treatment. Nevertheless, this volume is one which every house surgeon should possess and read, it will help to smooth his difficult path.

### The Surgical Technic of Abdominal Operations

By JULIUS L SPIVACK, M D, LL D, Associate Professor of Surgery, University of Illinois College of Medicine. Fourth edition  $9\frac{1}{2} \times 6\frac{1}{2}$  in Pp 709 + xvi, with 362 illustrations. 1946. Springfield, Ill: Charles C Thomas. \$10.00.

THE fourth edition of this volume has been thoroughly brought up to date and new material has been added. The technique of abdominal operations appeals to a vast number of surgeons, for the abdomen is practically the only part of the body which is left for the general surgeon.

The illustrations are of a high order and should be a stimulus for medical illustrations in this country. Every type of abdominal condition is dealt with in a masterful way, and we have nothing but praise for this book.

**Injuries of the Knee Joint** By I S SMILLIE, O BE, MB, FRCS (Edin), FRFPS, Surgeon-in-Charge, Orthopaedic Hospital, Larbert, Stirlingshire (Scottish EMS).  $9\frac{1}{2} \times 6\frac{1}{2}$  in Pp 320 + vi, with 350 illustrations. 1946. Edinburgh: E & S Livingstone Ltd. 35s net.

CONSIDERING the rather limited subject this is a large book, but it is based on a very extensive experience gained over a period of five years at an Orthopaedic Unit of a Base Hospital during the late war. In the preface the author draws attention to the very large number of such injuries which are incidental to military training and to the associated athletic activities. The book is based on personal experience and does not claim to represent a complete review of the extensive literature of the subject. Most of the excellent illustrations are the product of the author's own camera and pen, and in this respect he has made good use of his opportunities. The result is a book which will be valuable to those with sufficient experience to enable them to peruse its pages with discernment. It is scarcely a book for the beginner, though most valuable lessons are to be found in its pages like the reiterated advice with regard to the importance of the functional end-results and the methods by which they can be obtained, and especially the necessity for continuity in treatment. Some of the chapter headings give a good indication not only of the scope of the work but of the author's approach to the problems concerned, viz "The importance of the quadriceps", "The Surgical Anatomy and Physiology of the Menisci and Mechanism of their Injuries", "Injuries of Extensor Apparatus", "The Stiff Knee", and so on. Although the author adopts the old-time designation of "Internal Derangement of the Knee-joint" it is rather sad that there is no mention of Hey, of Leeds (1736-1819), the great pioneer in the elucidation of this disability, who taught us so much about the condition before the days of anaesthesia, X rays, or asepsis. Few surgeons are agreed about the best method of removal of the menisci, but the public have decided that the operation is worth while, so that we are bound to agree that there are many methods of attaining a satisfactory result. The operative management of the ruptured crucial ligaments is fully described but with rather more confidence than past experience would seem to have

justified, though the author does stress the need of longer and more detailed observation of the after-results

The section on fracture of the patella does not deal sufficiently with the after-care and lacks the details of after-results which would be so interesting and important

The concluding chapters, dealing with fractures about the joint, affections of bursa, the stiff knee, and certain other injuries, are interesting and suggestive. In a subsequent edition more information about after-results will very much add to the value of the work.

### **Surgical Treatment of the Motor-Skeletal System**

By 43 authors. Supervising Editor FREDERIC W. BANCROFT, A.B., M.D., F.A.C.S., Associate Clinical Professor of Surgery, Columbia University, etc. Associate Editor CLAY RAY MURRAY, M.D., F.A.C.S., Professor of Orthopedic Surgery, College of Physicians and Surgeons, Columbia University, etc. In two volumes 10 x 6 $\frac{1}{2}$  in. Vol I Deformities, Paralytic Disorders, Muscles, Tendons, Bursae, New Growths, Bones, Joints, Amputations. Pp 641 + ix, with 521 illustrations. Vol II Fractures, Dislocations, Sprains, Muscle and Tendon Injuries, Birth Injuries, Military Surgery. Pp 671 + ix, with 543 illustrations. 1946 Philadelphia and London J. B. Lippincott Co. £6

THE first of these volumes is devoted to general orthopaedics and amputations, the second is concerned with injuries and includes a section on war surgery. There are no less than forty-two contributors, all distinguished American surgeons (and one Canadian), and their writings together cover over 1200 pages. In spite of its size it is not altogether a work of reference, descriptions of methods of treatment in vogue outside the United States are not very frequent, it could hardly even be claimed that American orthopaedic practice in general is faithfully portrayed, since some of the contributions are very personal. The particular value of the book lies mainly in its breadth of scope, which is not confined to operative surgery, though the latter undoubtedly dominates the picture.

One fault is so glaring that it must be mentioned immediately—the obtrusiveness of the editor. There may have been editors who mistrusted their contributors more, but few can have given such clear and frequent expression of their lack of confidence. In almost every chapter there are longer or shorter paragraphs in brackets—written by the editor—supplementing, correcting, apologizing for, or commending what the particular contributor has written. It is as if the producer of a play were constantly rushing on to the stage and telling the audience that he, and not the actor before them, would show how the lines should be spoken. Here is the editor in a patronizing mood (p. 101, congenital dislocation of the hip) “the following excellent brief resumes of theoretical etiology, embryology, anatomy, and signs and symptoms are allowed here to stand since their bearing on treatment, rationale, and prognosis and on interpretation of results, while in many instances not direct, is nevertheless definite.” Why not leave the reader to judge the relevance or otherwise of the obviously excellent passage that follows? The editor could have applied himself rather more profitably to maintaining a proper balance between the various sections and eliminating the more obvious contradictions. In Volume I 40 pages are devoted to an excellent section on amputations, there is then a separate section of about the same length on amputation in diabetes and vascular disease with much vain repetition. Much of the chapter on war surgery is concerned with army medical administration, and where clinical matters are discussed there is a wholly irrelevant section on gas warfare. Other examples of editorial insufficiency are the appearance of discussions of those soft-tissue lesions known variously as

subdeltoïd bursitis, rupture of the supraspinatus, and Codman's shoulder on p. 312, in another section on p. 320, and yet again on p. 436. On p. 139 one learns that the removal of a wedge from the tarsus is not necessary in cases of acquired pes cavus. Yet in the section of poliomyelitis (p. 229) we are told how to do it and the operation is positively recommended. The clue to this puzzle is found on p. 138, where it appears that one of the writers concerned recognizes three kinds of pes cavus, congenital, paralytic, and acquired.

These faults are those of the work as a whole. The individual contributions are excellent and a number of them outstanding, von Lachum's section on the surgical treatment of scoliosis is a masterpiece, almost equally welcome is the chapter by McKittrick and Pratt on amputations in diabetes and vascular disease, A. G. Davis's chapter on injuries of the spine contains all essentials with just the necessary detail, Gordon Murray on injuries of the carpus is at home in a field of which he has made himself master. Not all, but many, of the other sections attain nearly the same standard as those mentioned, and considered as a collection of essays, this large—and expensive—work must therefore be considered a success. If, as we hope and think likely, a second edition is called for, a very heavy responsibility rests on the editor to knit the various sections more closely together and himself to retire into the background.

**The 1946 Year Book of General Surgery** Edited by EVARTS A. GRAHAM, A.B., M.D., Professor of Surgery, Washington University School of Medicine, etc. 7 x 4 $\frac{1}{2}$  in. Pp 679, with 213 illustrations. 1947 Chicago. The Year Book Publishers (London H. K. Lewis & Co. Ltd.) 21s net.

EVERY surgeon is interested in this little annual volume which Professor Evarts Graham edits with such skill. As year passes year the work of the general surgeon appears to increase in spite of the fact that many special departments of surgery have been taken away from him. General surgery still covers a wide field and the yearly production of published papers is ever increasing, and it is a real pleasure to read the fascinating précis that Graham has written of all new operations and forms of treatment. It is interesting to see that there is vogue and fashion even in surgery and that new operations are mere modifications at times of so-called old-fashioned techniques. More and more heroic operations are performed on the pancreas, and bowel, and all these are mentioned and given their proper place in this volume.

A most useful book containing a fund of interesting material.

**Confrontations radio-anatomo-cliniques** Publiées sous la direction de M. CHIRAY, R.-A. GUTMANN, et T. SENEQUE. Fascicule I 12 $\frac{1}{2}$  x 9 $\frac{1}{2}$  in. Pp 56, with 98 illustrations. 1946 Paris. G. Doin et Cie, Masson et Cie. 370 fr.

HERE is a volume, the first instalment of a series, of unrelated problems of gastro-enterology illustrated by radiographs and drawings.

**Diagnosis and Management of the Thoracic Patient** The American Practitioner Series. Edited by CHARLES PHILAMORE BAILEY, M.D. 9 x 6 in. Pp 334 + ix, with numerous illustrations. 1946 Philadelphia and London J. B. Lippincott Co. 24s net.

THIS symposium of articles on modern surgical practice in the management of the more important diseases of the intrathoracic organs is designed for the general practitioner and general physician, but it is sufficiently specialized to be of more value to the chest expert. It is a useful



book both for reading and reference and contains several outstanding articles, notably those on "Pulmonary Resection for Tuberculosis", by C P Bailey, "Primary Bronchogenic Carcinoma", by A Ochsner J L Dixon, and M De Bakey, and "Transthoracic Gastrectomy and Esophagectomy for Carcinoma of the Stomach and Esophagus", by R H Sweet

**Urologic Roentgenology** By MILEY B WESSON, M D, Ex-President, American Urological Association. Second edition, thoroughly revised  $9\frac{1}{2} \times 5\frac{1}{2}$  in. Pp 259, with 258 illustrations. 1946. London: Henry Kimpton. 27s 6d net.

This second edition reflects the advances made in urography, it has been largely re-written and the illustrations brought up to date. It is not merely an atlas of urological radiographs, for the text is most illuminating

and presents the accumulated wisdom of years of experience. In style it is both informative and entertaining, and it abounds in practical tips.

To be dogmatic is to invite criticism, we cannot agree with the statement that excretory urography is valueless in renal tuberculosis and the subsequent account of this condition makes us feel that the author himself does not believe it either.

The chapter on technique gives an indication of the thoroughness with which the information has been collected. It seems unfortunate that the American practice is to cut the right ureteric catheter obliquely for identification, and the left at right angles. The French slogan "Droit est droit, gauche n'est pas droit", which is prominently displayed in some French clinics, is more easily remembered.

The numerous illustrations cover the whole field of urology, and the production is excellent.

## BOOK NOTICES

[The Editorial Committee acknowledge with thanks the receipt of the following volumes. A selection will be made from these for review, precedence being given to new books and to those having the greatest interest to our readers.]

**A Synopsis of Anaesthesia** By J ALFRED LEE, M R C S, L R C P, M M S A, D A, Consultant Anaesthetist to Southend General Hospital, etc.  $7\frac{1}{2} \times 4\frac{1}{2}$  in. Pp 254 + viii, with 42 illustrations. 1947. Bristol: John Wright & Sons Ltd. 12s 6d net.

**L'Anesthésie intra-veineuse au Pentothal-sodium** By ERNEST KERN. With a Preface by R MERLE D'AUBIGNE.  $7\frac{1}{2} \times 5\frac{1}{2}$  in. Pp 94. 1946. Paris: Masson et Cie. Fr 100.

**Chirurgie de la Main** By MARC ISELIN, Chirurgien de l'Hôpital Américain.  $9\frac{1}{2} \times 6\frac{1}{2}$  in. Pp 360, with 135 illustrations. 1946. Paris: Masson et Cie. Fr 600.

**Le Chirurgien en Presence de l'Etat diabétique** By JACQUES BREHART, Ancien Chef de Clinique à la Faculté de Médecine de Paris, Chirurgien de l'Hôpital civil d'Oran. With a Preface by Professeur J SENEQUE.  $9\frac{1}{2} \times 6\frac{1}{2}$  in. Pp 544 + viii, with 44 illustrations. 1946. Paris: Masson et Cie. Fr 1200.

**A Synopsis of Orthopaedic Surgery** By A DAVID LE VAY, M S (Lond), F R C S (Eng), Honorary Orthopaedic Surgeon, Woolwich Memorial Hospital, etc.  $8\frac{1}{2} \times 6$  in. Pp 242 + viii, with 55 illustrations. 1947. London: H K Lewis & Co Ltd. 15s net.

**The Development of Inhalation Anaesthesia** With Special Reference to the Years 1846-1900. By BARBARA M DUNCUM, D Phil (Oxon), of the Nuffield Department of Anaesthetics, University of Oxford.  $8\frac{1}{2} \times 5\frac{1}{2}$  in. Pp 640 + xvi, with 161 illustrations. 1947. Published for The War Museum by Geoffrey Cumber. Press. 35s net.

**Pye's Surgical Handicraft** A Manual of Surgical Manipulations, Minor Surgery, and other matters connected with the Work of Surgical Diseases, House Surgeons, and Practitioners. Edited by HAMILTON BAILEY, F R C S (Eng), Surgeon, Royal Northern Hospital, London, etc. Fifteenth edition, fully revised.  $8\frac{1}{2} \times 5\frac{1}{2}$  in. Pp 668 + vii, with 789 illustrations, many coloured. 1947. Bristol: John Wright & Sons Ltd. 25s net.

**Hematomas Subdurales** By Dr ALFONSO ASENJO.  $7\frac{1}{2} \times 5\frac{1}{2}$  in. Pp 251, with 49 illustrations. 1946. Santiago, Chile: Stanley. Price not given.

**Heparin in the Treatment of Thrombosis** An Account of its Chemistry, Physiology, and Application in Medicine. By J ERIK JORPES, M D, Reader in Biochemistry, The Caroline Institute, Stockholm, Sweden. With a foreword by J R LEARMONTH, C B E, Ch M, F R C S E, Professor of Surgery, University of Edinburgh. Second Edition.  $8\frac{1}{2} \times 5\frac{1}{2}$  in. Pp 260, with 23 illustrations. 1947. London: Oxford University Press. 18s net.

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